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"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH

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SCIENCE EDUCATION IN GERMANY

II. THE POLYTECHNIC SCHOOLS

THE "Polytechnicum" is an institution peculiar to Modern Germany. It has for its object the teaching of all branches of the sciences of experiment and observation, not only in their principles, but in their applications to the industrial arts; these applications not being merely treated as illustrations of science, but regarded as the main subjects for instruction, for the sake of the understanding of which systematic courses on theoretic science are given.

The Polytechnica are altogether independent of the science departments of the Universities, but like these latter the Polytechnica are State institutions, the Professors (ranking generally somewhat below those of the University) are Government servants, and the current expenses are defrayed by State grants.

As a type of this interesting class of Science schools I may cite the two celebrated schools of Carlsruhe and Zurich, beginning with the Carlsruhe school with its 600 students.

In the original programme the school was declared to consist of *one* general and *seven* special departments. The general department, called the *Mathematical*, furnished instruction in mathematics, in natural science, and in modern languages and literature. It was viewed as preparatory to the special schools, and also as adapted for those who proposed to become teachers of mathematics and natural science. The seven special schools were of (1) civil engineering; (2) mechanical engineering; (3) architecture; (4) forestry; (5) manufacturing chemistry; (6) commercial studies; (7) civil service (*Postschule*). This constitution is in the latest programme, so far modified that (1) the general department is no longer treated in form as introductory to the rest, though it still appears to be so virtually; (2) the last two of the special departments enumerated above are omitted, while an agricultural department is added. The schools are, therefore, now seven, viz.:—

	Duration of complete course.
1. Mathematics	2 years
2. Civil Engineering	2½ ,,
3. Mechanical Engineering	2 ,,
4. Architecture	4 ,,
5. Chemistry	— ,,
6. Forestry	3 ,,
7. Agriculture	2½ ,,

The teaching staff consists of twenty-four professors with sixteen assistant lecturers and laboratory assistants. The appliances comprise five laboratories, viz. chemical, physical, mineralogical, and one for forestry and agriculture; a library; and twelve different cabinets or collections. In the department of natural philosophy, as many as 120 students attended the lectures of Professor Wiedemann in the summer semester of 1868. The cabinets are large and well-arranged. In the physical laboratory there were in the above year fourteen students, who went through the course of instruction in groups of four; most of these become teachers of the subjects in *Real-Schulen*; some get important posts in large mechanical workshops.

In Zürich exist both a University and a Polytechnic School; and although the university is a cantonal, and the school a federal institution, they are so far allied that they share one magnificent building, and many students of the university are, at the same time, pupils in the school. The total expense to the State for the maintenance of the Polytechnic School is 12,000*l.* per annum, whilst the original cost of the stately building itself was 160,000*l.* The professors of the two institutions, moreover, work to a certain degree in concert. For instance, Dr. Bolley is Professor of Chemistry in the school, and Dr. Städler, Professor of the same subject in the university. They have each a laboratory; but Professor Städler's is an analytical, and Professor Bolley's a technical laboratory. About 40 students work in the former, and 50 in the latter on an average.

There is less freedom allowed to pupils of the school, as to the classes to be attended, than is customary at the university. Definite courses are laid down; but relaxations are freely granted.

The most important department of this Polytechnic School is that of mathematics and engineering; there are also departments of forestry and agriculture, and an important department for teachers—a sort of technological seminary.

The Professor of Technical or Applied Chemistry, Dr. Bolley, lectures three or four times weekly throughout the session. He makes four or five sub-divisions of his course;—thus he lectures on the Chemistry of Colour; of Heating and Lighting; of Materials of Nourishment; and of Agriculture. Before entering this class, the student is required to have attended a course of theoretical lectures on chemistry, and an elementary experimental course.

Dr. Zeuner, the Professor of Engineering, gives about fifty or sixty lectures yearly on the Mechanical Theory of Heat; and he lectures six times a week for two semesters, on the Theory of Machines. The character of his courses is very high and rigorous; he insists on a knowledge of the differential calculus as a condition of entering his classes, and he remarked to the writer on the generally inadequate mathematical preparation of English students of engineering, mentioning his conviction that Professor Rankine, for whose works he expressed an unbounded admiration, must find the sphere of his efficiency as a teacher seriously limited by reason of the want of due preparation on the part of his students.

The following extracts from the prospectus of the lectures in the engineering department of the Zürich school, show how much more complete is the scheme of instruction there than has at present been found possible in England.

B. *Department of Civil Engineering.* (Duration of course, 3½ years.)

1st year.—Differential and Integral Calculus. Descriptive Geometry. Principles of Construction. Practice in Construction. Drawing. Experimental Physics. Experimental Chemistry.

2nd year.—Differential Equations. Technical Mechanics. Geometry of three dimensions. Perspective. Technical Geology. Topography. Drawing. Descriptive Mechanical Construction. Surveying.

3rd year.—Theoretical Mechanical Construction. Astronomy. Geodesy. Construction of Iron Bridges, Railways, and Iron Roofs. Drawing.

In addition to these courses there are similarly extensive programmes for (A) the department of Architecture, and (C) the department of Mechanical Engineering. The number of regular students in the year 1867, was in these subjects (A) department of Architecture, 33; (B) department of Civil Engineering, 103; (C) department of Mechanical Engineering, 87.

That the Polytechnic system of science education finds favour, at any rate, with the German State Governments, and therefore probably also with the people, is apparent from the fact that large institutions of the kind have just been built in Prussia (at Aix-la-Chapelle), in Austria (at Vienna), and in Bavaria (at Munich). In this latter city no less a sum than 125,000*l.* has been expended on the building of the new Polytechnicum, erected in a very costly style of architecture, and covering five acres of ground, whilst distinguished men from all parts of Germany have been called to fill the newly-founded professorships. The cost of the buildings at both Vienna and Aix-la-Chapelle will probably not be far short of the above amount, and it must be remembered that labour and material are very much (probably one-half) lower in Germany than with us. The expenses of education at the Polytechnica are very small; at Carlsruhe attendance on the regular courses of lectures costs 5*l.* 10*s.* for the session of nine months; the fee for chemical laboratory practice for the same length of time is 3*l.* 15*s.* to regular students, and 5*l.* to occasional students. At Zürich the fees are even lower, as any of the regular courses of the distinct departments or schools can be attended for the payment of 109 francs, or about 4*l.* 4*s.* for the session of nine months.

The age for entrance into the Polytechnic Schools is one year younger than that for the German Universities, viz. seventeen: the duration for study is the same, three years. Here, too, evidence of fitness is vigorously exacted of those who propose to enter as *regular students*, in the shape of an adequate school certificate, either from a gymnasium, a real-gymnasium, or a *Real-Schule;* or, in default of that, an entrance examination must be passed. A much higher mathematical preparation is demanded than is needed for entering the University, a knowledge at least up to, and in some schools including, the differential calculus being required. Persons of all ages, however, and not possessing such qualification, are admitted freely and without examination, as *occasional* students in the several departments. Many of these occasional students are often poorly prepared; but it is considered that the gain to such auditors, and to society through them, is great; and that, whatever tendency might arise from this practice towards the lowering of the standard of instruction could be guarded against by rigidly keeping up the standard of admission for regular students.

To many of the Polytechnica is attached a preliminary school, in which those who are not ripe for the full studies of the Polytechnicum can supply their deficiencies. The age for entrance to this *Vorschule* is sixteen.

In all the Polytechnica with which the writer is acquainted, it is the schools of civil and mechanical engineering, building construction, and architecture which really flourish. These departments of applied science are not represented in the German university system, whereas the study of chemistry in its various divisions, and of mechanics and physics in their numerous branches, forms a portion of every university course. Indeed, as a rule, the lectures delivered in the Polytechnic Schools on chemistry and physics differ very slightly, if at all, in character and scope from those which the University professor delivers. The fact is that the teaching of special technical chemistry in the Polytechnica has been found to be impossible. All that can be done in any school is, in the first place, to teach the groundwork of the science without regard to its applications, and then to point out the scientific principles upon which certain technical processes depend. No system of theoretical school instruction will fit a man to be a dyer or a calico-printer, or even a chemical manufacturer. These arts can only be learnt by practice on the large basis of practical experience, and all that Polytechnic Schools can do is to prepare the ground for a proper reception of that practical experience by a sound training in scientific principles.* This scientific training is, however, just as much the special work of the University as of the Polytechnicum, and there appears to be no valid reason for the separate existence, often side by side in one town, of a University and a Polytechnic School. On many grounds the absorption of the Polytechnicum by the University appears advisable. In the first place there is room to fear that a due supply of thoroughly good teachers, especially in science—at least in the higher positions—cannot be secured for institutions perpetually growing in number, while, on the other hand, a great waste of power is caused where such institutions exist side by side, as many of the professorships, being common to Universities and Polytechnic Schools, are thus twice represented.

Again, serious harm must come from the tendency which this separation of the Polytechnic School from the University has to foster the narrow one-sidedness already so strong in the extreme partisans of the one and the other group of studies. The Universities would suffer by the weakening in them of those branches of pure and applied science which have always been and must continue to be studied there. The Polytechnic schools would suffer (and already do suffer) from the tendency, thus encouraged, to neglect the *educational* aspects of science in considering its practical applications. How great the gain has been to the branches of the liberal arts and sciences from their alliance in Universities, the history of Universities from their first foundation abundantly shows: and it is difficult to see any sufficient reason why the applied sciences, such as Engineering, in their professional aspect should not have their proper place in the organisation of the University, exactly as Theology, Law, and Medicine have long had their place, to the great advantage both of these studies themselves and of the non-professional studies with which they have been brought into contact.

Signs are already observable in Germany, according to the highest authorities, that the zeal for teaching science in its application to the practical arts is encroaching on the domain of science proper, and that science will be deteriorated without, at the same time, industry being advanced. The true work of institutions,

* This is clearly admitted in certain cases by the Polytechnic authorities themselves. Thus I find in the regulations of the Carlsruhe Agricultural School the following words printed in large type:—"This school is concerned with the cultivation of the mind of the student, not with learning the technical operations of agriculture."

founded with the special aim of fostering the industrial arts, should be to insist on teaching *principles* systematically, and not in their isolated applications. To treat of the applications of the science is, of course, necessary, even for the sake of science itself; and under certain circumstances, some of these applications may wisely be dwelt on more than others; but this is quite a different thing from pretending to teach as *science* detached *fragments* of science in their application to this or that art.

The following extract from a well-known essay by Liebig, written so long ago as 1840, clearly shows that his views on this question coincide with those above expressed:—

"The teaching of science in the laboratories of the Trade—and Polytechnic—Schools is, in most places (in Prussia), very deficient. A system of true scientific instruction should fit a student for each and every possible application of science; for these applications become easy, and follow as a matter of course, from a knowledge of scientific principles. Nothing is more deleterious or dangerous than when utilitarianism is made the foundation of a system of tuition in a school, or when institutions, whose true aim ought to be experimental instruction in scientific principles, are employed to convert mere children into soap-boilers, brandy-distillers, or sulphuric acid makers. All this entirely destroys the true purpose of the institution.

"I have found, in all those attending my laboratory who intended to pursue a technical course of study, a general predisposition to devote themselves to some branch of applied chemistry. It is only with feelings of fear and trepidation that they consent to follow my advice, and give up the time they thus waste on mere drudgery to making themselves acquainted with the methods by which pure scientific problems are soluble, and by which alone they can be solved. . . . . There are many of my pupils, now at the head of many departments of manufacturing industry, who, having had no previous acquaintance with the processes, were in half an hour perfectly *au fait* with all the details of the manufacture, whilst in a short time they saw and introduced all sorts of necessary reforms and improvements. This power they had gained by being accustomed in their laboratory work to obtain the most accurate and precise knowledge of all the substances which came into their hands in their work; they had to learn the conditions necessary for avoiding errors, they investigated the properties of the products of decomposition formed, and thus became acquainted with the sources of error, with the means of avoiding losses; they were able to improve their apparatus, and to amend their processes. All this can never be learnt when the work is conducted according to cut-and-dry methods."

There are, no doubt, certain obstacles in the way of the proposed amalgamation in Germany; but in the old English Universities, and in the science colleges which we hope soon to see established in various parts of England, the difficulty would not arise at all. Apart from questions of tradition and historical routine, there can be no reason why students of applied science, led by their probable destination to manufacturing industry, should not study systematic science in the same class-rooms with students of the same subject who may have other aims: and if such students require minute practical and experimental instruction, there is no reason why they should not obtain this in physical and mechanical, as they do already in chemical, laboratories. In such a technical department, future teachers of science and leaders of manufacturing industry would be trained in the application of science to the most important branches of art and manufacture—so far, that is, as these are fit subjects for academic treatment; so far as they are not, they must be left to the workshop.

H. E. ROSCOE

VON SCHLICHT ON FORAMINIFERA

Die Foraminiferen des Septarienthones von Pietzpuhl. By E. von Schlicht. 4to. With 38 lithographic plates. (Berlin, 1870. London: Williams and Norgate.)

SINCE the appearance of D'Orbigny's "Foraminifères Fossiles du Bassin Tertiaire de Vienne," no work has been issued on the Foraminifera in their geological or palæontological relations, with pretensions at all corresponding to those of the newly-published monograph, the title of which stands at the head of the present article. We do not use the word *pretensions* in an offensive sense, for the author is careful to apprise his readers of the limitations of the treatise; but rather to indicate the sort of impression produced by the dimensions of the book and its profuse illustration. A quarto volume containing, in addition to the letter-press, thirty-eight large plates devoted to the Foraminifera of a small division of the Tertiary system of North Germany, and confined to a very limited district, or, as we might put it, 1,192 drawings of microscopic shells from the clay of a single brickyard, ought to show in its results a very evident *raison d'être* to save it from the imputation of labour thrown away. We need not require the expression of new or startling philosophical views to bring such a work within the scope of things worth doing; but we may fairly expect from so large an expenditure of labour and cost, some real and definite addition to our scientific knowledge. Whilst a smaller book might pass unnoticed, or at least without critical examination, one like this cannot escape without an inquiry as to what it contains of novelty, either in observation or theory,—in facts or their arrangement; and on the reply dictated by a patient study of its contents, the verdict as to its value must depend. To frame an answer to these questions which will serve to give an idea of the work, it will be necessary to offer a few preliminary observations and to epitomise the labours of previous observers in the same field.

In the Tertiary system of Belgium, and Northern and Central Germany, there occurs a thick bed of clay, containing nodules of argillaceous limestone, with radiating cracks or fissures in their interior, which have become filled with calc-spar. These nodules are termed "septaria," and they are regarded as sufficiently characteristic of the deposit to give it a name, though possibly a somewhat indefinite one. As used by German authors, the term "Septarienthon" includes the Rupelian clays of Rupelmonde and Boom, near Antwerp, the brick-clays of the neighbourhood of Berlin, together with similar beds in the valleys of the Maine and Elbe, and in many other localities between the Baltic and the centre of Germany. These beds are of Lower Miocene or Upper Eocene age, and belong to a group of transition strata, associated by

continental geologists under the name "Oligocene," which are scarcely represented in Great Britain. Possibly the fluvio-marine beds of the Isle of Wight are the nearest equivalent to be found in the Tertiaries of this country.*

The exact geological position of the Septaria-clay is of less consequence to our present purpose than the general fact that it was deposited some time during that earlier or middle Tertiary period in which the Foraminifera, as a zoological group, had their most conspicuous development. It is not surprising that so promising a field should have been diligently worked by German rhizopodists, and it may be questioned whether any single bed, or group of beds, has received so large an amount of attention in respect to its microzoa. The particular locality to which Herr von Schlicht's researches refer, is the estate or manor of Pietzpuhl, which lies at the highest point of a Tertiary ridge, commencing at the river Elbe, a little north of Magdeburg, and extending in an easterly direction above Möckern to Loburg,—a course of eighteen or twenty English miles. The clay-bed is worked at Pietzpuhl for bricks or some other economical purpose, and being open to-day, the investigation of its fossil fauna presents no preliminary difficulties.

Attention was first directed to the microzoa of the Septaria-clay just twenty years ago, in two letters from Herr Reuss (then of Bilin) to Herr Beyrich, on "Foraminifera in Clay, from Hermsdorf,"† which appeared in the Journal of the German Geological Society. These communications contained little beyond a list of the genera represented; but a year later, a third letter was published,‡ containing a good deal of supplementary information, and in 1851 Professor Reuss published a more elaborate paper "On the Fossil Foraminifera and Entomostraca of the Septaria-clays of the neighbourhood of Berlin,"§ containing the results of the examination of the beds described by Prof. Beyrich, together with a tabular comparison of the species obtained at Hermsdorf and Freienwalde with those of other well-known Tertiary deposits, such as the Miocene of the Vienna Basin and the sub-Appenine Pliocene clays. The table presents a series of sixty-five species, and of these, fifty-three are described and figured as "new." All except four of them were obtained from Hermsdorf. We will not enter into any analysis of the catalogue, else we might be tempted to exceed our bounds, in criticism on the new species.

Another letter from Prof. Reuss‖ gave similar particulars respecting two fresh localities, viz :—Gorzig near Köthen, and the excavations of Fort Leopold at Stettin. Shortly afterwards, appeared an elaborate paper by Dr. J. C. Bornemann of Leipsic on the "Microscopical Fauna of the Septaria-clay of Hermsdorf, near Berlin"** containing much of novelty and interest, and adding forty-six more "new species" of Foraminifera to an already extensive list. The figures of many of these show curious modifications of the simpler types, those of the genus *Polymorphina* being especially instructive. In 1858 Prof. Reuss contributed a further instalment to the literature of the subject in his paper "On the Foraminifera of Pietzpuhl,"†† and this concerns our present purpose more directly, as it is stated to be the first result of the author's examination of the specimens in Herr von Schlicht's collection. It is, however, little more than a catalogue, and introduces by name seventy-two more "new species," without either figures or descriptions.

Six years later Prof. Reuss published in the Reports of the Vienna Academy his researches "On the Foraminifera of the Septaria-clay of Offenbach"* near Frankfort, figuring therein forty-four more new species; and finally, in 1866, amongst the memoirs presented to the same scientific body appears an elaborate monograph by Prof. Reuss, entitled "The Foraminifera, Anthozoa, and Bryozoa of the German Septaria-beds,"† one of the most instructive, as well as one of the most beautifully illustrated of the author's many contributions to the history of the fossil Protozoa and Cœlenterata. This paper is not devoted, like its predecessors, to the description of new species, but is rather an epitome of the facts already known, with additional information as to distribution. It is supplemented by a comparative table of the geological and geographical relations of 228 reputed species, which is a sort of concentrated essence of the whole. Without compromising our radical objection to the system of sub-dividing and renaming, time after time, forms having the same essential characters, on account of minute and very variable peculiarities, or of regarding a slight difference in geological age as a reason for constituting a new species in cases where zoological characters fail to show ground of distinction, we may cheerfully yield to Prof. Reuss our tribute of admiration for his final summary of what was known of the microzoa of the Septaria-clay.

These bibliographical details have appeared necessary because the field of research to which they refer is one with which British palæontologists have little opportunity of becoming practically acquainted; and our object in respect to Herr von Schlicht's work is half accomplished now that we have indicated the amount of labour previously expended on the same subject.

Herr von Schlicht introduces his monograph by a preface of seven pages, comprising the readable matter of the volume. This introductory essay deals in generalities rather than new truths, and the apology of the author constitutes its chief novelty. After a few preliminary paragraphs he mourns the shortcomings of the work in respect to classification, nomenclature, and other important matters. Of the systems of classification, Prof. Reuss's, as last amended, is alone spoken of with much commendation; that of Prof. Max Schultze receives bare mention, as do also the views of British rhizopodists. "After all," asks the author, "do we know enough yet about the Foraminifera to invent any classification of them? Some people think not; and so, on the whole, although the early D'Orbignyan arrangement is the worst, it is pretty well known, and it will be the least trouble."

It may be that the systematic scheme laid down by Prof. Reuss is faulty: in this we should agree with Herr von Schlicht, though on different grounds; but it has a basis of natural relationship in its larger groups, wholly wanting in that of D'Orbigny. That a general harmony should exist between its sub-divisions and those indicated

* See a paper by Sir Charles Lyell, on the Belgian Tertiaries. *Quart. Journ. Geol. Soc.* vol. viii. p. 299.
† *Zeitschrift d. deutsch. geol. Gesellsch.*, vol. i. p. 259.
‡ *Ib.* vol. ii. p. 49. § *Ib.* vol. iii. p. 309. ‖ *Ib.* vol. iv. p. 76.
** *Ib.* vol. vii. p. 307. †† *Ib.* vol. x.

* *Sitzungsberichte der k.k. Akademie der Wissenschaften*, vol. xlviii.
† *Denkschrift der math.-naturwissen. Cl. der k.k. Akad. Wissensch.* vol. xxv.

by the independent researches of Dr. Carpenter and his colleagues in this country, is surely strong evidence in its favour; and the fact of its having been used in the latest publications on the particular subject of the work, gave it a strong claim for introduction, in spite of the alleged possibility of subsequent modification.

The author further laments the imperfection caused by his omission of specific or trivial names. In the prospect of a new and better classification, with the possible employment of different criteria for the separation of genera and species, every new specific name would, he thinks, only serve to increase the present confusion in nomenclature, and to augment the difficulties of future observers; besides, hints the author shrewdly, "thereby I have spared to myself a notable piece of labour." So the honour of appending specific names is willingly bequeathed to the future systematist who shall investigate the new forms, and who, we agree with Herr von Schlicht, will not be overpaid for his trouble.

Thus we are warned at the outset that, so far as nomenclature is concerned, no advantage is taken of the mass of plates which occupies half the volume. And yet, oddly enough, the author does name *one* of his figures—an attenuated, slightly curved, costate Nodosarian, with broad, clear, somewhat irregular sutures and pointed ends. This he calls *Dentalina edelina n.s.*, a name that might very well have been spared.

Notwithstanding the absence of trivial names, *genera* are recognised, and detailed descriptions are given of the specimens figured, with references to the plates. Thirty-two genera are adopted (two of them new), and *numbers* from 1 to 556, are appended to the descriptions instead of *names*. Some of the old generic terms employed are already regarded as untenable by those who had been in the habit of using them, and the two new ones are certainly needless. One of them, "*Atractolina*," represents a mixed lot of forms, some of them possibly compact fusiform *Polymorphinæ*, the remainder doubtful *Nodosarinæ*. In the case of two generic types which inosculate in their feebler varieties, as these most certainly do, we are ready to admit the difficulty of determining to which group a number of the intermediate forms belong; but to make a fresh sub-division for them cuts the knot rather than unties it. The other new genus, "*Rostrolina*," has no better foundation, based as it is on the mere shape of the terminal orifice—a straight or curved slit in the mucronate terminal chamber, instead of the circular or radiate aperture usually found. Specimens with this peculiarity have long been known, but have been regarded as mere individual modifications, and no previous writer has thought it necessary to invent even a specific name for them.

A good deal of criticism might be expended on the subdivisions and their arrangement, but we content ourselves with the passing remark that Reuss's type *Chilostomella* is out of place amongst the *Polymorphinidæ*, and that *Bolivina* is far separated by the author from *Bulimina*, which is its nearest ally.

We may sum up in a few sentences. Notwithstanding the work falls far short of what it might have been in many important particulars, it is of considerable value. The omission of any attempt to simplify the nomenclature, with the opportunity the large number of plates offered for doing so excellent a service, is inexcusable. It may be doubted whether a single new specific name would have been needed, and the plates might have been made the basis of a large reduction in those already in use. The best point of all about the book is the completeness of many of the series represented,—the consecutive links in the chain between a number of reputed species being in many cases all figured. It more than once occurred to us in turning over the plates, there must be something of dry humour about an author who could suggest that anyone who named the new forms would deserve all the honour he could get out of them, and that the fasciculus of plates was intended to demonstrate that the system of species-splitting could not be carried further than it had been carried by some previous authors, short of naming every specimen. On the other hand, from the large number of drawings devoted to the illustration of the minute morphological variations of a few simple types, the work affords valuable testimony to the truth of the views enunciated by Mr. W. K. Parker in his earliest paper on the Miliolitidæ of the Indian Seas, as to the impossibility of sub-dividing these lowest classes of animals by hard lines corresponding to the specific limits of more highly organised creatures; that a long series of forms presenting an extraordinary range of morphological variation may be grouped round sub-types, several of which merging at their edges into each other, and without any perceptible lines of demarcation between them, find in their turn a common central type, and that this type more nearly than any minor division represents what we are accustomed to term a species. If we regard Herr von Schlicht's volume from this point of view, we may easily see how it may possess considerable value, though not exactly of the sort that was intended by its author.

We should just add, that though the paper and letter-press are excellent, the plates are scarcely equal in solidity and clearness to the lithographic work we have been accustomed to see in German memoirs on the Foraminifera.

H. B. BRADY

ENCKE THE ASTRONOMER

Johann Franz Encke: sein Leben und Wirken. Von. Dr. C. Bruhns. (Leipzig, 1869. London: Williams and Norgate.)

FOUR years have passed since Encke died. Even those four years have witnessed notable changes in the aspect of the science he loved so well. But we must look back over more than fifty years if we would form an estimate of the position of astronomy when Encke's most notable work was achieved. At Seeberge under Lindenau, Encke had been perfecting himself in the higher branches of mathematical calculation. He took the difficult work of determining the orbital motions of newly discovered comets under his special charge, and Dr. Bruhns tells us that every comet which was detected during Encke's stay at Seeberge was subjected to rigid scrutiny by the indefatigable mathematician. Before long a discovery of the utmost importance rewarded his persevering labours. Pons had detected on November 26, 1818, a comet of no very brilliant aspect, which was watched first at Marseilles, and then at Mannheim, until the 29th December. Encke next took up the work and tracked the comet until January 12. Combining the observations made between

December 22, and January 12, he assigned to the body a parabolic orbit. But he was not satisfied with the accordance between this path and the observed motions of the body. When he attempted to account for the motions of the comet by means of an orbit of comparatively short period, he was struck by the resemblance between the path thus deduced and that of Comet I, 1805. Gradually the idea dawned upon him that a new era was opening for science. Hitherto the only periodical comets which had been discovered, had travelled in orbits extending far out into space beyond the paths of the most distant known planets. But now Encke saw reason to believe that he had to deal with a comet travelling within the orbit of Jupiter. On February 5, he wrote to the eminent mathematician, Gauss, pointing out the results of his inquiries, and saying that he only waited for the encouragement and authority of his former teacher, to prosecute his researches to the end towards which they already seemed to point. Gauss, in reply, not only encouraged Encke to proceed, but counselled him as to the course he should pursue. The result we all know. Encke showed conclusively that the newly discovered comet travels in a path of short period, and that it had already made its appearance several times in our neighbourhood.

From the date of this discovery, Encke took high rank among the astronomers of Europe. His subsequent labours by no means fell short of the promise which this, his first notable achievement, had afforded. If, as an astronomical observer, he effected less than many of his contemporaries, he was surpassed by few as a manipulator of those abstruse formulæ by which the planetary perturbations are calculated. It was to the confidence engendered by this skill that we owe his celebrated discovery of the acceleration of the motion of the comet mentioned above. Assured that he had rightly estimated the disturbances to which the comet is subjected, he was able to pronounce confidently that some cause continually (though all but imperceptibly) impedes the passage of this body through space, and so, by one of those strange relations which the student of astronomy is familiar with, the continually retarded comet travels ever more swiftly along a continually diminishing orbit.

Bruhns' life of Encke is well worth reading, not only by those who are interested in Encke's fame and work as an astronomer, but by the general reader. Encke the man is presented to our view, as well as Encke the astronomer. With loving pains the pupil of the great astronomer handles the theme he has selected. The boyhood of Encke, his studies, his soldier life in the great uprising against Napoleon in 1813, and his work at the Seeberge Observatory; his labours on comets and asteroids; his investigations on the transits of 1761 and 1769; his life as an academician, and as director of an important observatory; his orations at festival and funeral; and lastly, his illness and death, are described in these pages by one who held Encke in grateful remembrance as "teacher and master," and as "a fatherly friend."

Not the least interesting feature of the work is the correspondence introduced into its pages. We find Encke in communication with Humboldt, with Bessel and Struve, with Hansen, Olbers, and Argelander; with a host, in fine, of living as well as of departed men of science.

R. A. PROCTOR

OUR BOOK SHELF

Elementary Introduction to Physiological Science. (London: Jarrold and Sons.)

ANY one may teach the higher branches of science; none but masters should dare to give elementary instruction. The truth of this fundamental article of the teacher's creed is very strikingly confirmed by this little book, which professes to give uninstructed persons some elementary knowledge—first, of the chief chemical products of animal and vegetable life; secondly, of vegetable physiology; and lastly, of animal physiology. One of the rules of teaching which a real teacher has soonest and most forcibly brought home to him says, "Never use an illustration if you can do as well without it." The practice of the author of this work is evidently, "Never miss a chance of using a metaphor, or simile, or image, or illustration that occurs to you. If it is 'striking' or 'homely,' use it as often as you can." The author possibly understands his subject; we cannot tell for certain whether he does or no, for we cannot disentangle the real things from his striking illustrations of them. We never know whether he is speaking soberly or in metaphor, and we are perfectly sure that a lad of lively imagination, reading this book by way of an introduction to biology, would get into his head such fearful and vivid ideas of what was going on inside plants and animals, that no subsequent teaching could ever set him right, and life would ever afterwards be a burden to him.

Compendium der Physiologie des Menschen. Von Prof. Julius Budge. Zweite Auflage. (Leipzig: Günther. London: Williams and Norgate.)

VERY truly called a compendium, an account of as many as possible of the facts of human physiology being compressed into about three or four hundred pages. To a reader ignorant of physiology, the book would probably be wholly unintelligible; to a German student about to undergo an examination in physiology, it would doubtless be very acceptable, for by it he might refresh his memory on every point about which he is likely to be questioned. Perhaps after all, however, it is well for the English student that we have nothing like it in the English language. The author, in the second edition, has done his best to bring the work up to the level of the most recent knowledge. Unfortunately, however, science will not stop while an author is correcting proofs; and this, like all works professing to give the latest results, records not the ultimate but the penultimate researches. This is not, however, of very great importance; for, as in so many German physiological investigations the ultimate result is the exact opposite of the penultimate, it is very easy to calculate out the former from the latter, and add it on.

Chenes de l'Amerique Tropicale.—*Iconographie des Espèces nouvelles ou peu connues. Ouvrage posthume de* F. M. Liebmann, *achevé et augmenté d'un aperçu sur la Classification des Chênes en général, par* A. S. Oersted. Copenhagen, 1868. 1 vol. folio, 29 pp. Tabb. 57.

LIEBMANN was occupied at the time of his decease in 1856 with a monograph of the American Oaks. He left behind him a number of folio copper-plate engravings which he intended for the illustration of his work, and brief descriptions of fifty-two new species. These were entrusted for publication to Prof. Oersted, who has put all in proper train, drawn up a valuable essay on the classificatory characters of the genus, prepared an analysis of many of the species, and added ten plates of leaves of various species of oak in physiotype,—making altogether an important contribution to illustrated botanical literature, and a worthy memento of his friend. Liebmann died comparatively young, about thirteen years after returning from his botanical expedition in Mexico, where he amassed very fine collections, which are still in course of determination and distribution by the Danish botanists. A

short sketch of his life precedes Prof. Oersted's memoir, the substance of which had been already published in a scientific journal of Copenhagen.

The principal novel feature in Prof. Oersted's arrangement of the numerous species of oak—a genus including about 160 species in the Old World, and 120 in the New,—consists in the importance, for classificatory purposes, attributed to the form of the style and stigmatic surface. Upon these organs the sub-genera are chiefly based. We have had no opportunity of testing these characters, which it is unfortunate were not investigated by M. Alph. de Candolle, when preparing the *Cupuliferæ* for the "Prodromus," published in 1864. The omission of a Species-Index to the genus *Quercus* in the "Prodromus," makes it very tedious to ascertain how many of Liebmann's species are included in that work. Let us express the hope that in the final volume of this great work, yet to be published, we may be spared this annoyance in the case of the larger genera. D.O.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his Correspondents. No notice is taken of anonymous communications.*]

Prismatic Structure in Ice

Of late years attention has not unfrequently been called to this singular structure in ice, of which a number of instances are collected by the Rev. G. F. Browne, in his valuable book on the "Ice Caves of France and Switzerland" (chap. xviii.) In August, 1865, I had the opportunity of examining in his company some of these curious caverns; and since then have been on the look out for other instances of this structure. In January, 1867, I found it very well exhibited on a pond in Cambridge, an account of which may be found in the Proceedings of the Cambridge Philosophical Society, Part IV. and (more briefly) in my "Alpine Regions," pp. 94, 334. I again saw it last summer in a block of river or lake ice, which was brought on board a steamer at Christiansand (Norway) from an ice house. This block was about 8 inches thick. The prisms were rather irregular in form, the area of their ends varying from about a quarter of a square inch to one square inch, the sides being usually five or six in number. The prisms were at right angles to the planes of freezing, which were well marked.

These two were the only cases in which, from the first date until a few months back, I had succeeded in finding this prismatic structure clearly exhibited, but the present winter has proved very favourable to its development. I have seen it several times; in fact, after every severe frost; and under circumstances which have led me to suspect that I have often overlooked it on former occasions. In almost all the cases which I have lately noticed, the prisms were small, the area of their ends being generally about one-sixteenth of an inch. Hence, frequently the structure could not be detected without very close examination; as it was masked on the surface exposed to the air by the usual layer of disintegrating ice; and even when the under and unmelted side of a slab was examined, it had to be partly dried, before the delicate reticulation produced by the jointed structure could be observed by allowing the light to fall obliquely on it. The simplest mode of detecting it was to break the slab across, when instead of the usual conchoidal fracture of ice, a columnar structure was distinctly shown. Not unfrequently the first hint of its presence was given by the presence of a number of small holes in the under side of the slab. These, of course, were formed by water, which had trickled down from the thawing upper surface between the angles of the prisms, and had thus drilled itself a small tube. In one case—during a frost after a partial thaw—I found the structure mapped out, as it were, on the surface of the ice, but quite obliterated internally, except where some vertical lines of air bubbles marked the position of a tube or wider joint. In one of the cases above described, I totally obliterated the internal columnar structure by placing the ice in a freezing bath. I have often looked for, but never found it in glacier ice. I am therefore inclined to think that, though the large and strongly marked prisms are of comparatively rare occurrence, this finer structure may be found, if looked for, in every tolerably gradual thaw. Repeated examination has also convinced me that the structure has no immediate connexion with the hexagonal form of the ice crystals; the angles of the prisms are too irregular and variable to admit of this explanation. Their sides, however, so far as I have seen, are always at right angles to the surface of freezing, and are best developed when the temperature of the neighbouring air for a considerable time does not differ much from 32° Fahr. I therefore consider the structure to be produced by contraction in the ice as it approaches the melting point, and so to be analogous to the columnar structure in basalt, though due to a rise instead of to a fall in temperature.

St. John's College, Cambridge T. G. Bonney

A Probable Cause of Malaria

Since men of science, such as Dr. Carpenter, Jeffreys, and Wyville Thomson, have proved by repeated and well-conducted experiments that there is life in the ocean,* that there are moving, sensible, living creatures, of nearly every description, in its deepest recesses, it seems rather an idle question, "de lanâ caprinâ," which has been raised lately about their manner of living there; how they get their food where no plant of any description has ever grown; whether they take in their food by *intussusception* with a mouth, or by that kind of oozing-in-and-out styled endosmose and exosmose,† or by any other kind of absorption, suiting the glair-like sarcodic stuff which the eozoon of old was made up of, and which is still at work in building, roll upon roll, the myriads and myriads of microscopic *Globigerinæ*.‡ Yet these seemingly idle questions when treated by men of science and of experience may become the source of discoveries far greater and more important perhaps than they anticipate.

Thus it is that the indefatigable Italian diatomist, Count Castracane, after having proved the very abundant growth of his puny *protêgés* in the brackish waters of the *Maremme* and *Paludi pontine*, did not esteem it a bootless task to search for what they live upon, and also why they suddenly die away nearly all at once.

Such is the subject of a recent memoir which he has lately presented to the Roman Academy *Dei Lincei*, of which he is one of the most active members. After insisting upon the necessity of mastering the subject more thoroughly before attempting any new revision or classification of the diatoms, showing the system he had followed himself, and the results he had obtained, especially during the last year in making the round of the Istrian peninsula, taking his headquarters at Trieste and Pirano most particularly, where he gathered a rich harvest of very important materials for future study, he goes on to state that nothing is so fatal to the life of marine or even brackish water diatoms as a sprinkling of pure fresh water. This he proved by repeated and carefully performed experiments. From this fact he comes to the very probable conclusion that the sudden dying away of myriads of diatoms, besides, perhaps, myriads of other living creatures, during the rainy season might be, if not the only, at least one of the most efficient causes of *malaria*.

Before concluding this letter I wish to call the attention of the British scientific public to another Italian naturalist, M. A. Acorti, Professor of Natural History at the R. Gymnasium of Trieste, who has made the Adriatic a special subject of his studies, and is now engaged in the publication of the diatoms of that sea. "The sketching of his figures," says Count Castracane, "is of such beauty that I never saw anything better of the kind, and I hope they will be soon published that I may purchase them." J. Gagliardi

* We have now plenty of living Protozoa, Radiata, Annulosa, Mollusca, and even of Vertebrata *abyssicolæ*.

† On account of the porous substance, which is a speciality of those wonderful beings, Johnstone has classed them under the significant name of *Amorphozoa porifera*.

‡ After the late remarks on this subject by Prof. Wyville Thomson in Nature, it is curious to see the manner in which a Fellow of the Royal Society of the last century (John Ray) treated "the various ways of extracting the nutritious juice out of the aliment in several kinds of creatures. For oviparous quadrupeds," he says, "as chameleons, lizards, frogs, as also in all sorts of serpents" (there were, of course, no protozoa known in his time), "there is no mastication or comminution of the meat either in mouth or stomach; but as they swallow insects or other animals whole, so they void their skins unbroken, having a heat or spirits, powerful enough to extract the juice they have need of, without breaking that which contains it: as the Parisian Academists tell us. I" (subjoins Ray candidly) "cannot myself warrant the truth of the observation in all. I have taken two entire adult mice out of the stomach of an adder, whose neck was not bigger than my little finger. These creatures, I say, draw out the juice of what they swallow without any comminution, or so much as breaking the skin; even as it is seen that the juice of grapes is drawn as well from the rape (cluster), where they remain whole, as from the vat, where they are bruised, to borrow the Parisian philosopher's similitude."

The Motion of a Free Rotating Body

I SHALL feel obliged if, through the medium of your widely-circulated journal, you will allow me to point out an extraordinary mistake into which Mr. Radau has fallen, in a memoir inserted in the *Annales Scientifiques de l'Ecole Normale Supérieure* tom. vi. 1869, in which he criticises certain of my conclusions about the representation of the motion of a free rotating body contained in a paper published by me in the "Philosophical Transactions" for 1866. In his preamble, M. Radau says, speaking of the theory of rotation in connection with the names of Poinsot, Rueb, Jacobi, and Richelot:—"Tout récemment M. Sylvester a essayé d'appliquer au même sujet des considérations nouvelles qui l'ont conduite à des résultats intéressants, à côté d'autres dont l'exactitude peut être contesteé."

Later on in his memoir M. Radau points out, and accompanies with very biting (albeit toothless) criticism, the nature of his objection, which is, in short, that I suppose Poinsot's ellipsoid, under the influence of an original impulse, to roll without slipping by virtue of its friction against the plane with which it is in contact. My answer is, that of course I do. And why not? when I suppose the plane "indefinitely rough" (see p. 761 of "Philosophical Transactions," 1866), and have actually determined the friction and pressure at each point of the motion, so that by solving a maximum and minimum problem of one variable, the extreme value of the ratio of one of these forces to the other, or if we please to say so, the limiting angle of friction, or, in other words, the necessary degree of roughness of the plane may be analytically determined for every given case. M. Radau falls into the schoolboy blunder of making the *ratio between the friction and pressure constant throughout the motion*, confounding the actual friction with its limiting maximum value! It is, indeed, surprising that such a perversion of the facts of the case should have found insertion in a serious journal, such as that published by the Ecole Normale Supérieure, and I might fairly have expected from M. Radau the courtesy habitual with his adopted countrymen, of applying to me for information on anything in my paper which might have appeared to him obscure or erroneous, before rushing into print with such a *mare's nest*.

But out of evil cometh good. M. Radau says:—"Mais M. Sylvester va plus loin; il pense que le problème pourrait se résoudre par l'observation directe du mouvement d'un ellipsoide matériel tournant sur un plan fixe en même temps qu'il tournerait autour de son centre également fixe. On ne se figure pas facilement par quel artifice on fixerait le centre d'un ellipsoide matériel."

In a future number of your esteemed journal (as time at present fails me) I propose to show how, by the simplest contrivance in the world, a downright material top of ellipsoidal form may be actually made to roll, with its centre fixed, on a fixed plane and so exhibit to the eye the surprising spectacle of a motion precisely identical *in time*, as well as in its successive displacements of *position*, with that of a body, turning round a fixed centre, but otherwise absolutely unconstrained.

This mode of representation, which flashed upon my mind almost instantaneously when my eye first lighted upon M. Radau's objections, is the compensating good to the evil of being made the victim (to the temporary disturbance of my beloved tranquillity) of so hasty and futile a criticism as has been allowed insertion in the "Scientific Annals" of so great an institution as the Ecole Normale of Paris.

The *bureau de rédaction* must surely have been nodding when they allowed such observations, so easily refuted by turning to the original memoir, to pass unchallenged. It was only within the last few days that I received M. Radau's paper.

Athenæum Club, March 8 J. J. SYLVESTER

"Engrais Complet"

IN England many people have no faith in simple remedies with simple names, such, for instance, as brimstone and treacle; but make the same materials into a jam, disguise its flavour, and call it, say, the "Universal Purgative Extract," and then believers in its efficacy will soon be reckoned by the thousand. It seems from a review in a recent number of NATURE, that farmers in France are similarly incredulous on the subject of manures with intelligible names, that they require what is really useful to be mixed with something useless, and called "Engrais Complet," before they will apply it to their land. The English idiosyncracy benefits a large number of patent medicine vendors, and I presume this French variety of it benefits the manure merchants. Let us hope, however, that English farmers will continue to mix their own "Engrais Complet," obtaining, as heretofore, their nitrogen from farmyard manure, guano, and nitrogenous salts; their phosphorus from guano and superphosphate; their potash from organic excreta and potash salts. Under ordinary circumstances, with the Norfolk four-course system, the "Engrais Complet" for barley is left on the land by sheep feeding off roots and oil-cake; that for roots is farmyard manure and super-phosphate; that for wheat is clover roots, with a top-dressing of guano and salt. Clover requires little from the land but potash and good cultivation; but every crop should be fed well enough to leave something handsome for its successor.

Pray excuse my homely comparisons, for although a reader and I hope a student of NATURE, I am still

ONLY A CLOD

The Preservation of Mollusca

THE notice in a recent number of the use of creosote by M. Holbein for the preservation of mollusca, &c., leads me to remark that I have found it of great value for the preservation of coleoptera and other insects. The solution of creosote and water appears to be quite as effectual a preservative as alcohol, and does not harden the tissues or cause discoloration. After an immersion of about a week the solution should be drained off, and the insects placed in tins and covered with sawdust. Probably small reptiles, &c., could equally well be preserved in this way, which would save the danger of leakage and breakage which now ruins so many consignments.

Cambridge. J. R. CROTCH

Frankland and Duppa on the Action of Sodium on Acetic Ether

IN their recent communication to the Royal Society, reported in the last number of NATURE, Messrs. Frankland and Duppa ascribe my not getting hydrogen by the action of sodium on the acetic ethers to the high pressure existing in my sealed tubes.

How could there be a high pressure in my tubes unless I had first developed a large quantity of hydrogen? How then could it possibly be high pressure which prevented my getting any hydrogen? The pressure could not be due to the tension of the vapours of the acetic ethers, for in one experiment I employed acetate of amyl, which boils at 140° C., whilst I heated only to 100° C., and in this case, instead of getting 250 c.c. of gas, I got not a trace of gas. Moreover, the experiment with potassium was made in an open vessel.

On the other hand nothing is plainer than that Frankland and Duppa were operating upon alcohol as well as upon acetic ether, and hence their hydrogen.

London, March 3 J. ALFRED WANKLYN

Sir W. Thomson and Geological Time

I AM curious to know in which of his writings Sir W. Thomson makes the assertion "that there was a time when the earth rotated too swiftly for the existence of life." I cannot see how the assertion, even if it were true, could be of the least use in determining questions as to the length of time during which the earth has been habitable. Certainly it has not the slightest connection with Thomson's argument as to the date of consolidation of the earth, founded on its figure and on the retardation of its rotation by tidal friction. Yet the assertion is distinctly ascribed to Thomson—*first* in the *Pall Mall Gazette*, May 3, 1869, and *secondly* in the *Edinburgh Review* for January last.

If the passage quoted, or at least something resembling it, cannot be found in Thomson's writings, I am anxious to know whether the charge is due to simple stupidity on the part of the critics (or critic?), or whether it proves more?

G. H.

Little Gull (*Larus minutus*)

IN the proceedings of the Royal Physical Society of Edinburgh, as reported in NATURE, July 17, Dr. Smith notices the capture of a specimen of the Little Gull (*Larus minutus*) in Scotland, and remarks that it is a rare straggler to Scotland, only some two or three specimens having been previously recorded. Although rare in Scotland, it is by no means uncommon on the Yorkshire coast during the autumn and winter, and specimens are frequently shot during these seasons near Flamborough Head and along the Bridlington coast. This winter they have been more than usually plentiful. Mr. Richardson, of Beverley,

in a letter dated February 18, informs me "I have received thirteen Little Gulls, shot on the Bridlington coast during the last fortnight, seven adults and six immature." And, in a recent communication, "There have been twenty-nine Little Gulls shot in all, nineteen old and ten young birds."

I have a photograph of an adult bird in breeding plumage, with the black head, shot at Flamborough on July 13, 1868.

Great Cotes, Ulceby, Feb. 25 JOHN CORDEAUX

THE MICROSCOPIC FAUNA OF THE ENGLISH FEN DISTRICT

THE results of some recent researches amongst the Entomostraca of the rivers and "broads" of Norfolk and the adjacent counties have proved so interesting that a brief *résumé* of the subject will probably not be unacceptable to the readers of NATURE.

My attention was first directed to the district in the following manner:—My friend, Mr. E. C. Davison, a gentleman attached to the staff of H.M.S. *Porcupine*, has for several years interested himself very kindly, during the annual cruises of the vessel, in collecting for me such Entomostraca and other Microzoa as came in his way. Amongst the gatherings which thus came into my hands were two samples of sand from the Dutch rivers Maas and Scheldt, some similar dredgings from the English river Ouse (Norfolk), and one from Oulton Broad in Suffolk. The Dutch gatherings had been in my hands for several years, and their ostracoda described in the "Annals and Magazine of Natural History," before I received those from the English localities. An examination of these at once revealed a remarkable similarity between the inhabitants of all the localities—several species, up to that time unknown in Britain, being recognised as identical with some of those taken in Holland. This interesting observation induced me, in company with Mr. D. Robertson, of Glasgow, to visit the Fen district with a view of more thoroughly investigating its microscopic fauna—an inquiry which has resulted in very much strengthening our original view as to its close relationship with that of Holland, and seeming, moreover, to indicate that we have in the English fens a very remarkable group of Ostracoda and Foraminifera marked out by a hard and fast line, and forming a district fauna quite unparalleled in its isolation, as regards the surrounding British species.

The fact of a partial relationship between the fauna of the Fen counties, or East Anglian district, as we may conveniently call it, and that of North-Western Europe is not new; and the best account of the matter that I know of may be found in an interesting article on "The Fens," by the Rev. Canon Kingsley, in *Good Words* for 1867. The facts which most prominently indicate this relationship are the presence of various fishes of the family Cyprinidæ—roach, dace, &c., which attain their highest development in the rivers and lakes of Sweden,—of the "bearded tit," now however probably nearly extinct, and of the remains of the fresh-water tortoise, *Emys lutaria*, now an inhabitant only of Central and Eastern Europe, and whose presence in England can scarcely be accounted for except on the supposition of a free river communication between our island and the Continent during a bygone geological epoch. That the Straits of Dover were, indeed, not very long ago (geologically speaking) bridged over by dry land, and that at that time the rivers of North-Western Europe emptied themselves into one great estuary situated between us and the Scandinavian peninsula are well-established facts; and it is as giving additional confirmation to this belief by exhibiting perhaps more fully than has previously been done the close relationship of the fluvial faunas of East Anglia and Holland, that our present observations claim their chief interest. For it is evident that two faunas, possessing in common, even according to our present imperfect knowledge, a considerable number of species at once very peculiar in character, apparently very restricted in their distribution, and separated at the present time by a wide expanse of sea, must have sprung originally from one common centre, and can scarcely have been finally separated for any great length of time. The fishes to which we have referred have indeed spread, either through natural or artificial agencies, from the eastern rivers to other parts of England and even to Ireland. But this crustacean fauna seems to be rigidly confined to the Fen district of Norfolk and Suffolk on the western side of the German Ocean, and to the rivers of Holland on the eastern side. We make this assertion with some reserve, because much yet remains to be done in the examination of aquatic microzoa everywhere, and it is just possible that some of those species which we take to be peculiar to the Fen fauna may turn up elsewhere. But we have ourselves examined dredgings from many English rivers, especially on the east coast, and have explored in the search for Entomostraca (though without dredging), the lake districts of England and Southern Scotland, without ever meeting with any of them. In no part of the continent of Europe have the Entomostraca received so much attention as in Scandinavia, where, if anywhere, we should expect a similar fauna to be found. But neither Müller, Lilljeborg, nor Sars appears to have met with such. Nor does M. Felix Plateau's recent memoir on the "Fresh-water Crustacea of Belgium" mention any similar species, though we cannot help thinking that had the dredge been used there, the result would have been different.

Out of about 180 known species of British Ostracoda, eighty may be frequently met with in river estuaries or in marine situations where much fresh water habitually mingles with the salt. Of these, thirteen may be considered as coming down to the debatable ground from the fresh-water side and fifty-six from the sea; the remaining eleven haunt brackish water almost exclusively, so much so, indeed, that were they found to any large extent in a fossiliferous deposit, we should have no hesitation in saying that it was produced under brackish conditions.

Of about 100 species and varieties found in the Fen district and its outlets, sixty-eight may be looked upon as usual inhabitants of either marine or estuarine situations. These are met with chiefly in the river outlets, and being, doubtless, derived from the sea may be left out of sight in any consideration of the fauna of the Fens. Again, nineteen are widely-distributed fresh-water species, of which little need be said except that those of the genus *Candona*, especially *C. compressa*, *albicans*, and *lactea*, seem here to attain a finer development and to exist in much greater abundance than in any other district. In connection with this it is curious to observe that the genus occupies an intermediate position between the crawling, non-natatory marine Cytheridæ and the freely swimming fresh-water Cyprides. Twelve (?) species, mostly undescribed, seem to be entirely or almost entirely confined to the fens of England and the corresponding districts of Holland, for we regard their appearance in dredgings from the estuaries of the Scheldt and Meuse as evidence, not of their *living* in those situations, but of their probable abundant existence nearer the water-head. Dead shells of the same species are met with in a similar manner in the river outlets of Norfolk, such as the Ouse and Breydon water, their real habitat being the fresh-water "broads" and the dykes and rivers as high up as, and very probably higher than, Peterborough and Ely.

The peculiar species of the district are the following:—*Goniocypris mitra*, Brady and Robertson; *Metacypris cordata*, B. and R.; *Cypris fretensis*, B. and R.; *Cypridopsis Newtoni*, B. and R.; *Candona Kingsleii*, B. and R.; *C. hyalina*, B. and R.; *Cythere fuscata*, Brady; *Limnicythere monstrifica*, Norman; *L. Sancti Patricii*, B. and R.; *Polycheles Stevensoni*, B. and R.; with some few other species of which

few examples only have been found, and those are not yet fully worked out. Of the ten enumerated above, four of the most remarkable (*M. cordata, C. fuscata, P. Stevensoni, C. fretensis*) have occurred in the gatherings from the Meuse and Scheldt. The new species are not yet published, but will shortly be fully figured and described by the present writer, in conjunction with Mr. D. Robertson, in the *Annals and Magazine of Natural History*.

The Foraminifera of the broads and fen rivers are scarcely less interesting than the Entomostraca, and embrace some new species and varieties; we are not yet, however, in a position to institute any comparison between them and those of the Dutch rivers. One point of interest may be noticed, that although, on the site of Whittlesea mere, Foraminifera are very abundant, scarcely any are to be met with in the river Nene, which is closely adjacent. This would seem to indicate that the faunas of the two places are independent of each other, or, at any rate, that the Foraminifera of the Fens are not recruited indirectly from the sea through the medium of river communication.

In conclusion it must be said that the free-swimming Entomostraca of the whole fen district present, so far as we have found, nothing calling for remark; many of the common fresh-water Lyncei and Copepoda are very abundant in the broads, rivers, and dykes, throughout the district; but had it not been for the use of the dredge we should have found nothing of great interest. *Not one* of the new species would have been found (though one of these is everywhere abundant, and some of the rest by no means rare), except *Goniocypris mitra*, of which one or two detached valves were observed in a gathering from Somerton Broad.

The explanation of the origin of this peculiar fauna is perhaps not very easy. If we might be allowed to speculate, we should say that it is probably the last surviving representative of a group of species which may have inhabited in remote times a large, lagoon-covered district possibly continuous between this country and Holland, the water of which we should suppose to have been ordinarily but slightly brackish. Possibly if this condition lasted during any great period of time, the species in question may have been developed by a process of modification from those inhabiting the estuaries on one side and the fresh water on the other. But two or three of them are so far removed in character from any others with which we are at present acquainted that it is impossible to speak more positively on the subject. Enough has been said to show that the subject is one of no little interest, and that the waters of the districts referred to would very probably well repay the labours of investigators in other departments of natural history.

G. S. BRADY

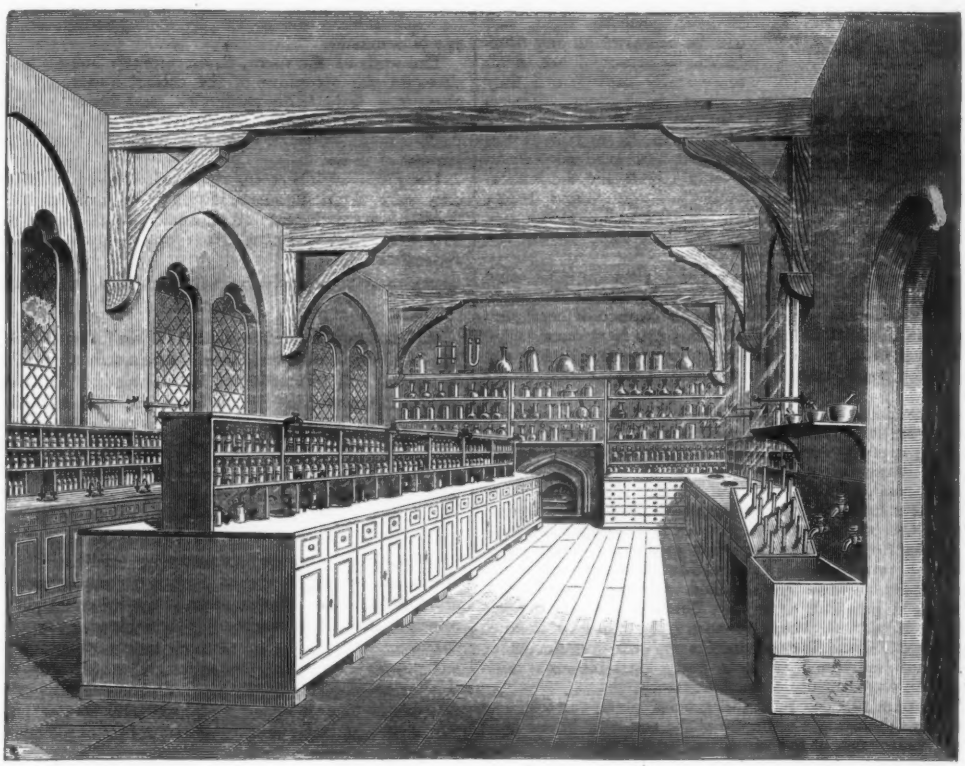
Polychelea Stevensoni, magnified 40 diameters: (*a*) seen from side; (*b*) seen from below. The young fry are seen through the translucent shell at its posterior end. The species is probably viviparous.

Metacypris cordata, magnified 84 diameters: (*a* seen from side; (*b*) seen from below.

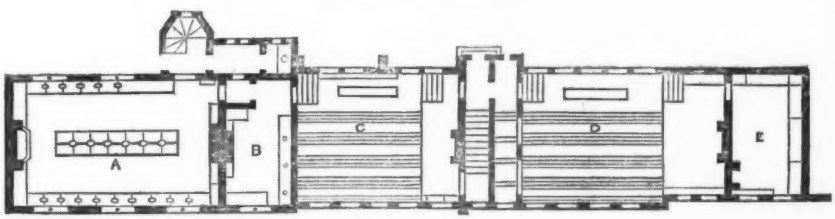
Goniocypris mitra, magnified 84 diameters: (*a*) seen rom side; (*b*) seen from below.

THE NEW NATURAL SCIENCE SCHOOLS AT RUGBY

ALTHOUGH a brief notice of the new schools at Rugby has already appeared in the pages of this journal, a more detailed account of them may not be unacceptable to the readers of NATURE, especially at a time when so much attention is being paid to the subject of science teaching in schools.



GENERAL VIEW OF LABORATORY



GROUND PLAN

SCALE OF FEET

0 5 10 20 30 40 50 60

The accompanying ground-plan will show the general arrangement of the rooms.

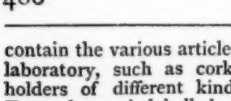
The laboratory is 35 ft. by 22, and is intended to accommodate thirty boys. It is not, properly speaking, one of the new schools, as it was formerly the only Natural Science lecture-room; but it has been much altered and entirely refitted, in order to convert it into a laboratory. The working tables are divided into compartments, seven on each side of the centre table, and ten and six in those along the sides of the room. Each compartment comprises a cupboard and two drawers, two shelves for bottles, two gas taps, waste basin with water supply, and a working space of 3 ft. 6 in. by 1 ft. 9 in. The water taps and basins in the central table are placed so as to serve for boys working on either side, and thus much space is gained. The water taps have a small orifice, and are specially adapted for filling test tubes. A water pipe is also carried along the highest shelf and there are taps at intervals for filling tall vessels, for working with Liebig's condenser, &c.

The sink, with arrangements for washing and drying bottles, is seen near the door in the drawing.

At one end of the room is an open fireplace, with shelves and nests of drawers on either side. The drawers

contain the various articles that are in general use in the laboratory, such as corks, cork-borers, elastic tubing, holders of different kinds, glass tubes and rods, &c. Every drawer is labelled on a simple plan that I find very convenient.

A bit of zinc is bent at an angle of 45°. The two edges of the one half are then just turned over, and the whole is screwed to the front of the drawer. A card slipped under the turned-down edges is held perfectly tight, and can be removed at any time. Labels so arranged are much more easily seen than if they were simply fastened to the face of the drawers. (One is shown in the figure.)



The lower shelves above the drawers contain all the dry chemicals required in Harcourt and Madan's "Practical Chemistry" (the book we chiefly use in the laboratory), together with the more costly re-agents, and others that are in less frequent use. Each boy has a complete set of all the ordinary acids and test solutions on the shelves of his compartment.

The contents of the drawers and shelves on either side of the fire-place are arranged in duplicate—a complete set on each side. In this way all chance of confusion and crowding is avoided, as no boy can have occasion to cross over from the side of the room on which he is working to the opposite side, everything being ready to his hand.

A common balance with sets of gramme weights is placed on the table above each nest of drawers. Here also are kept the various measuring flasks and cylinders. At the other end of the room is an ordinary six-feet kitchen range, which has been slightly modified so as to serve for a furnace. It has sand-bath, boiler, and drying-oven. On one side of the furnace is a cupboard to contain a stock of glass and porcelain apparatus. On the other side are two spacious evaporating closets with sliding glass doors. These are supplied with hoods and jets for creating a powerful draught. The draught can be still further increased, when necessary, by lighting a large ring of jets in the flue communicating with the closets.

A small cupboard for tools and a glass-blower's table complete the furniture of the laboratory.

The room marked B, in the ground plan, was formerly the only laboratory for the use of the school. It was built some years ago, at the same time as the Natural Science lecture-room, and, though small, was exceedingly well arranged. It is now converted into a private laboratory for the use of the chemical lecturer. It contains a large evaporating closet, also a sand-bath and distilling apparatus, both of which are worked by the fire in the school laboratory by means of appropriate dampers. Here also is the flue for obtaining a down-draught at the lecture-table in the adjoining chemical lecture theatre. As several pipes open into this flue it was found necessary to place the large ring of gas-jets for creating the draught at a considerable elevation above the floor. To light this ring an artifice was employed that it may be worth while to mention. A supplementary gas-pipe was carried alongside of the supply-pipe from a few feet above the floor to the ring of jets. This was pierced with small jets at short intervals all the way to the top. A separate tap turns on the gas in this pipe, and upon applying a light to the lowest jet the flame runs rapidly up the pipe and lights the ring at the top. The gas is then turned off from the supplementary pipe and the ring alone left burning.

From the private laboratory a door opens into the chemical lecture-room. This is provided with seats for fifty boys, the forms and desks rising tier above tier so that experiments at the lecture table are well seen by all. The down draught at the lecture table, already alluded to, is most useful. Experiments with chlorine may be performed with hardly any smell escaping.

The theatre is well supplied with shelves, cupboards, apparatus cases, diagram-screens, and black-board. There is also a capital cellar for stock chemicals, batteries and empty cases.

The Physical Science lecture theatre, D, is of still larger dimensions, and will hold sixty boys. A space at one end is fitted up with work-tables, &c., where experiments may be prepared, and also where boys may themselves learn how to use physical apparatus under the eye of a master.

The walls of the room, E, are entirely lined with glass cases for the reception of the school apparatus. Here, also, is a lathe with table-vice and bench, where an assistant, accustomed to mechanical work, can make various lecture illustrations, and repair instruments that are out of order.

I ought to add that the Natural Science Schools are only part of an extensive block of new buildings containing several classical and other schools, and that the whole has been erected from the designs of Mr. W. Butterfield.

T. N. HUTCHINSON

NOTES

M. DELAUNAY is the new director of the Paris Observatory. We must congratulate the French Government upon their appointment. M. Delaunay, who has just received the Medal of our Royal Astronomical Society for his researches on the moon's motion, is an astronomer second to none, and is in every way admirably qualified for such an important post.

AT the Royal Society's Soirée on Saturday last, a number of interesting objects were exhibited, among which we may mention Mr. Roberts's specimens of electro-deposited iron; Mr. Siemens specimens of cast steel from the Landore-Siemens Works; a chronoscope of elaborate construction, exhibited by Capt. Noble, for recording at one observation the velocity with which a projectile passes different parts of the bore of a gun. The principle of this instrument is that of registering, by means of electric currents, upon a recording surface, travelling at a uniform and very high speed, the precise instant at which a shot passes certain defined points in the bore. It is capable of indicating intervals of time as minute as one-millionth part of a second. We shall again refer to some of the objects exhibited.

AT the meeting of the Royal Society last week, the names of the candidates for election, fifty-three in number, were read. From these, in accordance with the usual practice, fifteen will be chosen to be elected by the Fellows of the Society in June next. Last year the number of candidates was forty-five.

AT the same meeting two short papers were read from Mr. Le Sueur, who has charge of the great telescope at Melbourne, giving an account of his observations of some of the nebulæ included in Sir John Herschel's Cape Catalogue. The details are interesting, and full of promise for the future; as are also the particulars of spectroscopic observations of Jupiter which accompany the observations of nebulæ.

THE *Athenæum*, in reporting that Mr. Hind has issued a circular showing the path of the moon's shadow in the eclipse of the sun which will take place on the 22nd December, remarks that it is to be hoped that our Government will send out an expedition thoroughly equipped with spectroscopes to settle the nature of the corona, one of the last remaining questions of solar physics.

IT is satisfactory to know that the Municipal authorities of Glasgow are alive to the prospective benefits which their city is likely to gain, in a sanitary point of view, from the investigations which are to be instituted by the Sewage Committee

of the British Association. If any city more than another needs the sanitarian besom it must surely be Glasgow, when it is remembered that it enjoys the unenviable notoriety of having the highest death-rate of all the great towns of the kingdom. Its desire to get this stigma removed is indicated by the fact that the Police Commissioners, at their last meeting, on the motion of a genuine sanitarian, the chairman of the Health Committee, voted the sum of 100*l.* towards defraying the expenses of the British Association Committee referred to above. We understand that the fund already amounts to upwards of 1,000*l.*

THE Swiney Lectures on Geology are to be delivered at the London Institution, by Dr. Cobbold, F.R.S., commencing on March 10th. During the course it is proposed to discuss, among other subjects, "The scope and tendency of the physical and biological sciences," "The best modes of acquiring adequate conceptions of geologic time," "Evidences of the incompleteness of the geological record," and "The claims of geology as an aid to the acquirement of high mental culture."

ON the 13th of January died F. T. Otto, Professor at the Polytechnic School of Brunswick, known chiefly as the translator of Graham's "Elements of Chemistry." Two editions of this translation having been rapidly sold, a third edition was commenced in 1852, in which the plan of the original was entirely changed. Otto treated mineral chemistry in three volumes; theoretical chemistry being reserved to Buff, Kopp and Zamminer, and organic chemistry to Kolbe and Fehling. Otto's chemical researches were not considerable. His books, however on the manufacture of vinegar and on agricultural industry are held in great esteem. Otto was born in Saxony in 1809.

THE paper to be read on Thursday at the Royal Society, by Mr. Warren de la Rue, Dr. Balfour Stewart, and Mr. Loewy, is expected to be of great interest.

PROFESSOR UNGER, of Vienna, a well-known botanist, whose death we reported last week, was, it is now stated, found murdered in his bed at Graz; and no trace of the murderer has as yet been discovered. A priest has taken this opportunity to assert from the pulpit at Cilly, Styria, that the body of the late philosopher had probably been destroyed by the devil himself, who had just claims upon his soul!

WE learn from the *Society of Arts Journal* that a Hygienic Council, attached to the Turkish Ministry of the Interior, has been created, with the function of improving the drainage, enforcing proper street scavengering and public cleanliness, both in the capital and throughout the provinces. Its further duty will be to improve existing civilian hospitals, and establish new ones where needed.

THE examination of candidates for the Royal Agricultural Society's prizes will take place in the week commencing 26th April.

THE Royal Asiatic Society offer to treat with any learned Society for the use of rooms in their new premises in Albemarle Street, which are more than they require.

THE *Photographic News* announces the death of Mr. Bingham, an English photographer long resident in Paris, and at one time assistant to Faraday.

THERE is a talk of an International Congress of Geographers at Antwerp. Many eminent French *savants* have promised to take part.

MR. ALGLAVE reports in the *Revue des Cours Scientifiques* that the Sars Fund now amounts to about 260*l.*

WE acknowledge the receipt of the ninth number of the *Free Sunday Advocate*, with a supplement, containing Professor Huxley's lecture "On the forefathers and forerunners of the English people"—a paper by Wm. Duthie, Esq, "On the social economy of Sunday, stating reasons for the opening of picture galleries, museums, and gardens, and running railway trains and steamboats on Sunday"—also the first of Dr. Carpenter's lectures "On the physical conditions and animal life of the deep sea."

Cosmos complains that the approaching réunion at the Sorbonne instead of being an assemblage of philosophers is to be merely a gathering of students, to compete for and receive prizes.

WE acknowledge the receipt of the Meteorological Tables for the Quarter ending 31st December last by Mr. Glaisher.

THE *Revue des Cours Scientifiques* states that the botanical collection formed by Baron Delessest, and since maintained by his son, who died lately, has been left to the town of Geneva. The library has been deposited in the Academy of Sciences.

WITH reference to Prof. Stanley Jevons's paper, read last month at the Royal Society, on the representation of logical processes by mechanism, it seems right to mention that Mr. Alfred Smee, F.R.S., published a book twenty years ago on the "Progress of Thought," in which engravings were given of a machine for the representation of mental operations. At present it is difficult to see what would be the utility of such machines; but if they are to be regarded as a step towards one that will some day be really useful, then the invention may be accepted as something more than an ingenious curiosity.

IN the report of the Royal Commission on Pollution of Rivers, the presence of arsenic in the water and mud of rivers near alkali works is pointed out, and it is also stated that the London sewage at Barking contains as much as ·004 of arsenic in 100,000 parts.

THE *Levant Herald* states that the Turkish Government is about to adopt the French Metric System. It is to be gradually brought into use. The oke very nearly corresponds to the kilogramme.

THE second of a course of weekly lectures on subjects connected with Economic Science, especially as concerned with labour and capital, under the auspices of the Social Science Association, was delivered inthe house of the Society of Arts, John Street, Adelphi, on Tuesday evening, by Frederick Hill, Esq., on "The Identity of the Interests of Employers and Workpeople." The chair taken by George Godwin, Esq.

THE Council of the Society of Arts will consider the award of the Albert medal early in May next.

AN injunction has been granted to restrain the Corporation of Leeds from discharging sewage into the river Aire.

THE first Exhibition of Spring Flowers at the Gardens of the Royal Botanic Society, is to take place on the 30th and 31st of this month.

AT a Session of the Council of University College, London, on Saturday last, Mr. George Grote, president, in the chair, Mr. Henry Maudsley, M.D. Lond., Fellow of the College, was appointed Professor of Medical Jurisprudence. A Whitworth Exhibition of 25*l.* was awarded to Mr. Robert Forsyth Scott, a student of the college.

THE new chemical laboratory erected for the use of the scholars at Eton College has just been opened for school purposes, under the superintendence of Mr. Madan. There are two large rooms, one of which will be used for lectures and the other for school purposes.

FROM a circular lately issued to the Government science teachers, we learn that the Lord President and the Vice-President of the Committee of Council on Education have found it advisable to modify the provisions of the Council's minute of the 30th November, 1869, in reference to the mode of paying those teachers for their arduous work of instructing the industrial classes in elementary science. Since the teachers

held their meeting at Manchester, the complaint which they brought against the Science and Art Department of breach of faith, and repudiation of engagements made with them, has been pressed upon the Government by a strong force of Lancashire and Yorkshire members of Parliament.

THE *British Medical Journal* states that Prof. Agassiz is ill from nervous prostration and over-work, not being able even to write letters.

THE Gulstonian Lectures for this year will be delivered at the Royal College of Physicians, by Dr. Maudsley, on the 11th, 16th, and 18th of this month, the subject being "The Relations between Body and Mind, and between Mental and other Nervous Disorders." The Croonian Lectures will be on "Aneurism of the Heart," and will be delivered by Dr. Gibson on the 23rd, 25th, and 30th of March. The subject of the Lumleian Lectures on the 1st, 6th, and 8th of April, will be "The Natural History and Diagnosis of Intra-Thoracic Cancer," by Dr. J. R. Bennett. The lectures will commence in each case at 5 o'clock.

THE Acclimatation Society of Paris has awarded to Mr. P. L. Simmonds its silver medal, of the first class, for his paper on "Silk cultivation and supply," read before the Indian Conference of this Society last year. A similar medal has been awarded to Mr. G. W. Hart, of Hayling Island, for his labours in oyster culture.

THE Instituto Tecnico of Palermo has published another part of the *Giornale di Scienze Naturali ed Economiche*, which well sustains the character of the work. Among the papers therein contained we notice—"Avifauna del Modenese e della Sicilia," "Sui materiali per costruzione di mattoni refrattarii per le zolfare," "Nuove specie di funghi," "Determinazione del luogo chimico nelle sostanze aromatache," and "Studii palæontologici sulla fauna del calcario a telebratula janitor del nord di Sicilia." Besides all this, the part contains eight numbers of the *Bulletino* of the Royal Astronomical Observatory at Palermo, in which are records of observations astronomical and meteorological, notices of sun-spots and magnetic perturbations, and on shooting-stars and meteors, with lithographic illustrations. It is gratifying to find that even in Sicily science is making progress.

THE Government of India has lately sanctioned the commencement of the Damoodah Canal, at an estimated cost of about 540,000*l*. Its total length will be just 100 miles. One end of it will terminate in the heart of the Bengal coal-fields, and it will thus be the means of affording a cheap line of transport for carrying coals into Calcutta, relieving at the same time the railway of a portion of that traffic. A secondary but very important result of this canal is likely to be the drainage of the tract of land lying between the railway and the Damoodah, which for the last seven years has been desolated by malarious fever.

WE learn that the success of the Lectures for Women during the present term has equalled the most sanguine expectations of the originators of the scheme. Between seventy and eighty ladies are now attending eight courses of lectures, the number of attendances (counting each lecture separately) being in all 115. The committee proposes to issue in June a complete programme of the lectures for the next academical year. The present courses will be continued during the next (Easter) term at the present hours, unless special notice of a change be given.

WE have received from the Hydrographic Office of the Admiralty a copy of the notice to mariners stating that, on or about the 1st of April next, a telegraphic station vessel will be moored by the International Mid-Channel Telegraph Company off the entrance to the English Channel, in from fifty-five to fifty-nine fathoms water, in lat. 49° 20′ 30″ N., long. 6° 17′ W. of Greenwich. The vessel will be painted black, with the words "Telegraph Ship" in white letters on her sides; she will have three masts. At the top of the mainmast a large black cone will be hoisted during daytime, and a powerful globular light at night, elevated thirty feet above the sea, which in clear weather should be seen from a distance of six miles. A flare-up light will also be shown every fifteen minutes during the night, from an hour after sunset to an hour before sunrise. During foggy weather, day or night, a bell will be rung continuously for half a minute every quarter of an hour; and for the first six months, or until the 1st day of October 1870, a gun will be fired every quarter of an hour, and after that date every hour. The commercial code of signals for the use of all nations will be used on board, to the exclusion of all other codes, and none other can be noticed. In reference to this, M. Delehaye remarks in the *Bulletin* of the Association Scientifique of France that it will be of great service to navigation by saving time, and obviating risk and expense. For meteorological purposes also he believes this station will be very useful. He might have extended his list.

*ON THE TEMPERATURE AND ANIMAL LIFE OF THE DEEP SEA**

I.

THE present discourse embodies the most important general results obtained by the exploration of the deep sea in the neighbourhood of the British Isles, carried on during the summer of 1869 in H.M. surveying vessel *Porcupine*, with the view of completing and extending the inquiries commenced in the *Lightning* expedition of 1868, of which an account was given by the speaker at the Friday evening meeting of April 9, 1869.†

The expedition of the *Porcupine* was divided into three cruises. The first of these, which was placed under the scientific charge of Mr. J. Gwyn Jeffreys, F.R.S., accompanied by Mr. William L. Carpenter, as chemical assistant, commenced from Galway near the end of May, and concluded at Belfast at the beginning of July. It was directed in the first instance to the south-west, then to the west, and finally to the north-west as far as the Rockall Bank. The greatest depth at which temperature-sounding and dredging were carried on in this cruise was 1,476 fathoms; and these operations, through the excellent equipment of the *Porcupine* and the skill of her commander, Captain Calver, were so successfully performed, that it was confidently anticipated that still greater depths might be reached with an equally satisfactory result.

The second cruise, which was under the scientific charge of Prof. Wyville Thomson, F.R.S., with Mr. Hunter as chemical assistant, was consequently directed to the nearest point at which a depth of 2,500 fathoms was known to exist, viz., the northern extremity of the Bay of Biscay, about 250 miles to the west of Ushant. In this cruise temperature-sounding and dredging were carried down to the extraordinary depth of 2,345 fathoms, or nearly three miles—a depth nearly equal to the height of Mont Blanc, and exceeding by more than 500 fathoms that from which the Atlantic Cable was recovered. This sea-bed, on which the pressure of the superincumbent water is nearly three tons for every square inch, was found to support an abundance of animal life; about 1½ cwt. of "Atlantic mud," chiefly consisting of *Globigerinæ*, having been brought up in the dredge, together with various types of higher animals, Echinoderms, Annelids, Crustaceans, and Mollusks; among them a new Crinoid—referable, like the *Rhizocrinus*, whose discovery by M. Sars, jun., had been the starting-point of the present inquiry—to the *Apiocrinite* type which flourished during the Oolitic period.

The third cruise was under the scientific charge of the speaker, with Mr. P. H. Carpenter as chemical assistant; but he had the great advantage of being accompanied by his colleague Prof. Wyville Thomson, who, as in the *Lightning* expedition, took the entire superintendence of the dredging operations. The object of this cruise, which commenced in the middle of August and terminated in the middle of September, was a more thorough exploration of the area between the North of Scotland and the Faroe Islands, which had been found in the *Lightning* expedition to afford results of peculiar interest in regard alike to the inequality of temperature and to the distribution of animal life on the sea-bed, which here ranges between the comparatively shal-

* A Lecture delivered at the Royal Institution.
† Proceedings of the Royal Institution, vol. v. p. 503.

low depths of from 350 to 650 fathoms—the last-named being the greatest depth to which dredging had been carried in 1868.

The weather, during nearly the whole of the *Porcupine* expedition, was as favourable to its work, as during the greater part of the *Lightning* expedition it had been unfavourable; and the results obtained not only far exceeded the most sanguine expectations of those who had promoted it, but may be said, without exaggeration, to be such as no previous scientific exploration of so limited an extent and duration is known to have yielded.

The results of the temperature-soundings will be first stated, with their bearing on the doctrines advanced in the former discourse as probable inferences from the observations made during the *Lightning* expedition. These observations indicated that two very different submarine climates exist in the deep channel which lies E.N.E. and W.S.W. between the North of Scotland and the Faroe Banks; a minimum temperature of 32° having been registered in some parts of this channel, whilst in other parts of it, at the like depths, and with the same surface temperature (never varying much from 52°), the minimum temperature registered was never lower than 46°,—thus showing a difference of 14°. It could not be positively asserted that these minima are the bottom-temperatures of the Areas in which they respectively occur: but it was argued that they must almost necessarily be so:—first, because it is highly improbable that sea-water at 32° should overlie water at any higher temperature, which is specifically lighter than itself, unless the two strata have a motion in opposite directions sufficiently rapid to be recognisable; and secondly, because the nature of the animal life found on the bottom of the cold area, which consists of quartzose sand including volcanic particles, exhibited a marked correspondence with its presumed reduction of temperature, whilst the sea-bed of the warm area is essentially composed of *Globigerina*-mud, and the animal life which it supports is characteristic of the warmer-temperate seas.

This conclusion, it is obvious, would not be invalidated by any error arising from the effect of pressure on the bulbs of the thermometers; since, although the actual minima might be, as was then surmised, from 2° to 4° below the recorded minima, the difference between temperatures taken at the same or nearly the same depths would remain unaffected.

The existence in the cold area, of a minimum temperature of 32°, with a Fauna essentially Boreal, could not, it was argued, be accounted for in any other way than by the supposition of an under-current of Polar water coming down from the north or north-east: whilst, conversely, the existence in the warm area, of a minimum temperature of 46°, extending to 500 or 600 fathoms' depth, in the latitude of 60° (being at least 8° above its isotherm), together with the warmer-temperate character of its Fauna, seemed equally indicative of a flow of equatorial waters from the south or south-west.

It was further urged that if the existence of two such different submarine climates in close proximity can only be accounted for on the hypothesis of an Arctic stream and an Equatorial stream running side by side (the latter also spreading over the former in consequence of its lower specific gravity), these streams are to be regarded (like the Gulf Stream) as particular cases of a great general Oceanic Circulation, which is continually bringing the water cooled-down in the Polar regions into the deepest parts of the Equatorial ocean-basins, whilst the water heated in the Equatorial regions moves towards the poles on or near the surface. Such a circulation was long since pointed out to be as much a physical necessity, as that interchange of *Air* between the Equatorial and Polar regions which has so large a share in the production of winds; but whilst physical geographers remained under the dominant idea that the temperature of the deep sea is everywhere 39°, they could not fully recognise its importance.

These doctrines have been fully tested by the very numerous and careful temperature-soundings taken in the *Porcupine* expedition; and the result has been not merely to confirm them in every particular—so that they may now take rank as established facts,—but also to show that a temperature 2½° below the freezing-point of fresh water may prevail over the sea-bed in a region far removed from the Polar, and that even this extreme reduction is by no means antagonistic to the existence of animal life in great variety and abundance.

All the temperature-soundings of the *Porcupine* expedition were taken with thermometers protected from the effects of pressure by the enclosure of the bulb of each instrument in an outer bulb, sealed round the neck of the tube; about three-fourths of the intervening space being filled with spirit, but a small vacuity being left, by which any reduction in the capacity of the outer bulb is prevented from communicating pressure to the inner. This plan of construction, which was suggested by Prof. W. A. Miller, has been so successfully carried into practice by Mr. Casella, that thermometers thus protected have been subjected to a pressure of three tons on the square inch, in a testing-machine devised for the purpose, without undergoing more than a very slight elevation, of which a part, at least, is attributable to the heat given out by the compression of the water in which they were immersed: whilst the very best thermometers of the ordinary construction were affected by the same pressure to the extent of 8° or 10°, the elevation in some instruments reaching as much as 50° or 60°.* Two of these protected Miller-Casella thermometers were used in each observation, and they always agreed within a fraction of a degree. The same pair was used throughout the expedition; and notwithstanding that they were used for 166 separate observations, in which they travelled up and down nearly 100 miles, they came back in perfectly good order; a result mainly due to the care with which they were handled by Captain Calver. It may be affirmed with great confidence that the temperatures which they indicated were correct within 1° (Fahr.); an approximation quite near enough for the scientific requirements of the case.

In order to connect the work of the *Porcupine* with that of the *Lightning* expedition, it will be desirable to commence with the third cruise of the former, in which a detailed survey was made of the area traversed in the preceding year by the latter. In this cruise bottom-soundings were taken at thirty-six different stations, at depths varying from 100 to 767 fathoms; of these, seventeen were in the cold area and fourteen in the warm, whilst five exhibited intermediate temperatures, in accordance with their border position between the two. In order to ascertain whether the minimum temperatures thus obtained were really the temperatures of the bottom, serial soundings were taken at three stations, of which one was in the warm area and two in the cold—the temperature at different depths between the surface and the bottom being ascertained by successive observations, at the same points, at intervals of 50 or 100 fathoms. All these results agreed extremely well with each other; and they closely accorded with the fifteen observations made in the *Lightning* expedition, when the requisite correction for pressure (from 2° to 3° according to the depth) was applied to the latter.

The following general summary of these results brings into marked contrast the conditions of the warm and cold areas, which occupy respectively the W.S.W. and E.N.E. portions of the Channel between the north of Scotland and the Faroe Islands, and lie side by side in its midst.

The surface-temperature may be said to be everywhere nearly the same, viz. 52°; the variations above and below this being attributable either to atmospheric differences (as wind, sunshine, &c.) or to difference of latitude. Alike in the warm and the cold areas there was a fall of from 3° to 4° in the first 50 fathoms, bringing down the temperature at that depth to 48°. A slow descent took place nearly at the same rate in both areas through the next 150 fathoms; the temperature in the warm area at the depth of 200 fathoms being 47°, whilst in the cold it was 45·7°. It is below this depth that the marked difference shows itself. For whilst in the warm area there is a slow and pretty uniform descent in the next 400 fathoms, amounting to less than four degrees in the whole, there is in the cold area, a descent of fifteen degrees in the next 100 fathoms, bringing down the temperature at 300 fathoms to 30·8°. Even this is not the lowest; for the serial soundings taken at depths intermediate between 300 and 640 fathoms (the latter being the greatest depth met with in the cold area, midway between the Faroe and the Shetland Islands) showed a further progressive descent; the lowest bottom-temperature met with being 29·6°. Thus, while the temperature of the superficial stratum of the water occupying the cold area clearly indicates its derivation from the same source as the general body of water occupying the warm area, the temperature of the deeper stratum, which may have a thickness of more than 2,000 feet,

* See Prof. W. A. Miller's "Note upon a Self-Registering Thermometer, adapted to Deep Sea Soundings," in "Proceedings of the Royal Society," June 17, 1869.—The same principle had been previously applied in thermometers constructed under the direction of Admiral Fitzroy; the space between the two bulbs, however, being occupied with mercury instead of spirit. Owing, however, to some imperfection in their construction, their performance was not satisfactory, and they were found very liable to fracture.

ranges from the freezing point of fresh water to 2½° below it. Between the two is a stratum of intermixture of about 100 fathoms thickness, which marks the transition between the warm superficial layer and the body of frigid water which occupies the deeper part of the channel.

The shortest distance within which these two contrasted submarine climates were observed at corresponding depths, was about 20 miles; but a much smaller distance was sufficient to produce it when the depth rapidly changed. Thus near the southern border of the deep channel, at a depth of 190 fathoms, the bottom-temperature was 48·7°; while only six miles off, where the depth had increased to 445 fathoms, the bottom-temperature was 30·1°. In the first case, the bottom evidently lay in the warm superficial stratum; whilst in the second it was overflowed by the deeper frigid stream.

It seems impossible to account for these phenomena on any other hypothesis than that of the direct derivation of this frigid water from the Arctic basin. And this agrees very well with other facts observed in the course of the exploration. Thus:—(1) The rapid descent of temperature marking the "stratum of intermixture" began about 50 fathoms nearer the surface in the most northerly portion of the cold area examined, than it did in the most southerly, as might be expected from the nearer proximity of the cold stream to its source. (2) The sand covering the bottom contains particles of volcanic minerals, probably brought down from Jan Mayen or Spitzbergen. (3) The Fauna of the cold area has a decidedly Boreal type; many of the animals which abound in it having been hitherto found only on the shores of Greenland, Iceland, or Spitzbergen.

Although the temperatures obtained in the warm areas do not afford the same striking evidence of the derivation of its whole body of water from a southern source, yet a careful examination of its condition seems fully to justify such an inference. For the water at 400 fathoms in lat. 59½° was only 2·4° colder than water at the same depth at the northern border of the Bay of Biscay, in a latitude more than 10° degrees to the south, where the surface-temperature was 62·7°; and the approximation of the two temperatures is yet nearer at still greater depths, the bottom-temperature at 767 fathoms at the former stations being 41·4°, whilst the temperature at 750 fathoms at the latter point was 42·5°. Now, as it may be certainly affirmed that the lowest temperature observed in the warm area is considerably above the isotherm of its latitude, and that this elevation could not be maintained against the cooling influence of the Arctic stream but for a continual supply of heat from a warmer region, the inference seems inevitable that the bulk of the water in the warm area must have come thither from the S.W. The influence of the Gulf Stream proper (meaning by this the body of superheated water which issues through the "Narrows" from the Gulf of Mexico), if it reaches this locality at all—which is very doubtful—could only affect the most superficial stratum; and the same may be said of the surface-drift caused by the prevalence of south-westerly winds, to which some have attributed the phenomena usually accounted for by the extension of the Gulf Stream to these regions. And the presence of the body of water which lies between 100 and 600 fathoms' depth, and the range of whose temperature is from 48° to 42°, can scarcely be accounted for on any other hypothesis than that of a great general movement of Equatorial water towards the Polar area; of which movement the Gulf Stream constitutes a peculiar case modified by local conditions. In like manner, the Arctic Stream which underlies the warm superficial stratum in our cold area, constitutes a peculiar case, modified by the local conditions to be presently explained, of a great general movement of Polar water towards the Equatorial area, which depresses the temperature of the deepest parts of the great Oceanic basins nearly to the freezing-point.

W. B. CARPENTER

SOCIETIES AND ACADEMIES

LONDON

Royal Society, March 3.—The following papers were read:—"Results of the Monthly Observations of Dip and Horizontal Force, made at the Kew Observatory, from April 1863 to March 1869 inclusive." By Dr. Balfour Stewart. "Spectroscopic observations on stars and nebulæ made with the Great Melbourne Telescope." By A. Le Sueur. "On the nebula of Argo, and on the spectrum of Jupiter." By A. Le Sueur. We shall return to these papers next week.

Geological Society, February 18.—Annual general meeting, Prof. T. H. Huxley, president, in the chair. The secretary read the Reports of the Council, of the Library and Museum Committee, and of the Auditors. The general position of the society, as evinced by the state of its finances, and by the continued increase in the number of its members, was stated to be very satisfactory. In presenting the Wollaston Gold Medal to John Evans, Esq., for transmission to M. G. P. Deshayes, the president requested him to transmit it to M. Deshayes as an expression on the part of the Geological Society of the high estimation in which his services to palæontology and geology, especially in regard to the classification of the tertiary formation, are held by the geologists of this country; adding, that six years ago the council of this society demonstrated the interest which it took in M. Deshayes's valuable investigations by awarding him the Donation-fund. Now that those researches, commenced just fifty years ago, are completed, and the labours of a life devoted to science are crowned by the publication of five great volumes containing descriptions and figures of all the mollusca of the Paris basin, it has seemed to the Council a fitting opportunity for bestowing the highest honour at its disposal upon the pupil, editor, and continuator of Lamarck, and the worthy successor of his great master in the Chair of Natural History in the Muséum d'Histoire Naturelle. Mr. Evans acknowledged on the part of M. Deshayes, the award of the Wollaston Medal, and read a letter from M. Deshayes expressing his sense of the honour conferred upon him. The president presented the balance of the proceeds of the Wollaston Donation-fund to Mr. Evans, for transmission to M. Rouault, Keeper of the Geological Museum at Rennes, in aid of his researches upon the Palæontology of the Devonian and Silurian Rocks of Brittany, and remarked that the cosmopolitanism of science was well illustrated by the fact that all the honours at the disposal of the society this year are gladly accorded to foreigners.—The President then read his anniversary address, prefaced by biographical notices of deceased Fellows, including Prof. Brayley, F.R.S.; Dr. Hermann von Meyer; Dr. B. Shumard; Dr. Roget, F.R.S.; Prof. Graham, F.R.S.; Prof. Jukes, F.R.S.; Dr. W. Clarke, F.R.S.; Mr. J. W. Salter; the Vicomte d'Archiac, &c. The ballot for the council and officers was taken, and the following were duly elected for the ensuing year:—President: Mr. Joseph Prestwich. Vice-Presidents: Sir P. de M. G. Egerton, R. A. C. Godwin-Austen, Sir Charles Lyell, Bart., Warrington W. Smyth. Secretaries: P. Martin Duncan, John Evans. Foreign Secretary: Professor D. T. Ansted. Treasurer: J. Gwyn Jeffreys. Council: Prof. D. T. Ansted, William Carruthers, W. Boyd Dawkins, P. Martin Duncan, Sir P. de M. G. Egerton, John Evans, David Forbes, J. Wickham Flower, Capt. Douglas Galton, R. A. C. Godwin-Austen, Harvey B. Holl, J. Whitaker Hulke, Prof. T. H. Huxley, J. Gwyn Jeffreys, Sir Charles Lyell, George Maw, John Carrick Moore, Prof. John Morris, Joseph Prestwich, Warrington W. Smyth, Rev. W. S. Symonds, Rev. Thomas Wiltshire, Henry Woodward.

Zoological Society, February 24.—Dr. E. Hamilton, V.P. in the chair. A communication was read from Mr. R. Swinhoe containing some information on the subject of the exact locality of the Amherst's pheasant (*Thaumalea amherstiæ*), which was stated to be the mountains between the Chinese province of Sechuen and Tibet.—A letter was read from Sir George Grey in reference to Professor Owen's communication of a letter from Dr. Haast read at the previous meeting. Sir G. Grey was of opinion that there were good grounds for believing that the *Dinornis* had been extirpated by the direct ancestors of the present race of Maories.—A second letter was read addressed to the Secretary by Mr. W. H. Hudson on the ornithology of Buenos Ayres.—Mr. Sclater exhibited a specimen of a new lemur, which had been lately discovered by Mr. Van Dam in North-eastern Madagascar, and had been named by Mr. Pollen *Propithecus damanus*.—Messrs. C. H. T. and G. F. L. Marshall read some notes on the classification of the birds of the family *Capitonidæ*.—Two communications were read from Mr. R. Swinhoe on the white wag-tails (*Motacillæ*) of China, and on a new species of *Accentor* from Northern China proposed to be called *A. erythropygius*.—Mr. P. L. Sclater read a paper on the deer living in the Society's menagerie, amongst which there were stated to be examples of several recently described and very little known species. Mr. Sclater concluded his paper with remarks on the arrangement and the geographical distribution of the *Cervidæ*, and in particular of the species of the genus *Cervus*. The total number of *Cervi* recognised as probably

valid species were twenty-three in the Old World and seventeen in the New World.

Chemical Society, March 3.—Prof. Williamson, F.R.S, president, in the chair. Mr. Ch. P. Sandberg, of Stockholm, was elected a fellow of the society. The first paper was by Dr. Gladstone on "Refraction Equivalents," to which we shall return. The next paper was by Dr. Thudichum, on "Kryptophanic Acid," a normal ingredient of human urine. The substance is obtained from the primary material by first forming its lime salt, transforming this by neutral lead-acetate into lead-kryptophanate, and decomposing the latter by sulphuretted hydrogen. Kryptophanic acid is an amorphous, gummy mass, transparent and nearly colourless. It forms salts with the alkalis, the alkaline earths, and other metals. Mercuric nitrate produces in the aqueous solutions of its earthy salts a white precipitate; the ordinary analysis for urea is thus shown to be liable to error. The acid is dibasic, and has the formula $C_5H_9NO_5$, but in some instances it may be viewed as tetrabasic and in that case its formula must be written $C_{10}H_{18}N_2O_{10}$.

Linnean Society, March 3.—Mr. J. E. Howard read a paper by Mr. Broughton, chemist to the cinchona plantations in the Madras Presidency, "On hybridisation among cinchonas." He believes that the sub-varieties of *Cinchona officinalis* are permanent, but that hybrids can be artificially obtained, although they do not occur in nature. The cinchona has long been known to belong to the class of dimorphic plants. In the discussion which followed, Dr. Anderson, superintendent of the Botanic Gardens at Calcutta, gave some interesting particulars of the cultivation of cinchona at the Darjeeling plantations.—Dr. Hooker read a very interesting and important communication from Sir Henry Barkly, Governor of Mauritius, on the "Fauna and Flora of Round Island," a very little-known dependency of that colony. Although only about twenty-five miles from Port St. Louis, and the intervening sea not more than 400 feet deep, both plants and animals differ not only in species, but also in genera, from those of the Mauritius. The exploring party were only in the island one day, but during that time they captured four species of snakes and several lizards, no species of either family being found in the Mauritius. The insects and shells obtained were also peculiar, one of the latter being a *Cyclostoma*. Of flowering plants only twenty-four species were collected, but of these more than half were not natives of the Mauritius, including three species of palm, a *Pandanus*, or screw-pine, and two species of ebony. One of the palms is between thirty and forty feet high; another is similar to the Mauritian *Areca alba*, but different; and a third has a most remarkable bottle-shaped stem. Round Island is only about three miles in circumference and one and a quarter across. It consists of a mound of tufa about 1,000 feet in height, very little vegetation being found in the lower part. Sir H. Barkly believes the area to be one of elevation rather than subsidence.

Royal Archæological Institute, March 4.—The following papers were read:—"Remarks on a piece of Roman sculpture, found at Sens, and representing fresco painting." By Mr. J. G. Waller.—"On the Emerald Vernicle of the Vatican, with notices of other ancient portraitures of Our Saviour." By Mr. C. W. King, M.A.—"On an ancient Alms-box, found at Browne's Hospital, Stamford." By the Rev. C. Nevinson, warden of the hospital. Among the objects exhibited were a drawing of a leaden vessel containing Roman coins, found in Cornwall, by the Hon. W. O. Stanley, M.P.—Fragment of Anglo-Saxon M.S., found at Stamford Court, Worcester, by Sir T. E. Winnington, Bart.—Silver plate engraved with historical and allegorical subject, three portraits in Dresden porcelain, by Mr. Octavius Morgan, M.P.—Stone and bronze implements, found in Lincolnshire, by the Rev. E. Jarvis.

Anthropological Society, March 1.—Dr. Beigel, V.P., in the chair. Mr. Robert Wright and Dr. Hilliard, were elected Fellows. "On the Circassian slaves and the Sultan's harem." By Major Millingen. The author showed by what means the Turks insured to themselves in former days a supply of white slaves, so as to recruit their armies and their harems. The facts stated by the author with regard to the slave-trade seemed to prove that, from the highest to the lowest, all the ladies of Constantinople, those at least who have capital to invest, are regular slave-dealers. The author subsequently showed that the use of white slaves is a necessity for Mussulman nations on religious, social, and state-policy reasons, as slavery serves to keep women under subjection and in a state of seclusion; while politically it is indispensable for the maintenance of the reigning dynasty, whose matrimonial alliance with any other but slaves is against the statutes of the empire. A description of the seraglio then followed, its organisation being accurately exposed, while ample details were given concerning the wives and odalisks of the Sultan. In the seraglio the lot of the Circassian slaves was said to be better than that which befalls the generality of slaves; there they are provided with everything, and can attain high honours and power. The system was condemned by the author on account of its being a source of ruin and depravity for both slave and master. The author maintained that it is impossible that the Turks should seriously think of doing away with slavery for the reason that it is so much a part of the social and political edifice, that an attempt to alter the existing state of things would inevitably hasten its downfall. In conclusion, he said that if the Turks, instead of importing women and good-for-nothing slaves, had given their minds to peopling their half-deserted country with an emigration of hardy and industrious men, Turkey might be now at the head of the civilised countries of the earth.—Mr. E. Charlesworth exhibited some remarkable flint implements from Honduras.

Royal Geographical Society, February 14.—Sir R. Murchison, president, in the chair. "On the Runn of Cutch and neighbouring regions." By Sir Bartle Frere. The author defined the region as a broad belt of country between the Indus on the west and the Arivalli Mountains on the east, extending from the Himalaya to the Peninsula of Cutch on the Indian Ocean; the length was about 600 miles, and its breadth varied from 100 to 150 miles. The southern portion, called the Runn of Cutch, forms a level plain 150 miles in length, distinguished by the total absence of vegetation. It forms, during the greater part of the year, a plain of firm sand, saturated with salt, on which the hoofs of horses and camels in passing make scarcely any impression. It is so level that a heavy rainfall remains like a vast slop on the surface, and is blown about by the wind until it evaporates. During the south-west monsoon, however, the high tides flow into it and cover it with water to the depth of one or two feet. Travellers and caravans pass over it, but are sometimes lost, for there are absolutely no landmarks; the danger is somewhat lessened on the side of the hills of Cutch by a beacon-fire which is regularly lighted by a Mahommedan family there settled, to whom has descended the religious duty of thus guiding the wandering traveller over this desolate waste. The surface remains damp even in the driest season, and the soil never pulverises. Mirage and other surprising atmospheric phenomena are common in this singular district. North of the Runn the desert waterless tract is called the Thurr. The whole region slopes very gradually from the sub-Himalayan ranges, between the Jumna and the Sutlej, towards the south-west. The rivers descending from these lower ranges disappear as they advance into the desert, and none of them reach the Indus. The Thurr is covered with a constant succession of sandy ridges, rising as high as 200 feet above the valleys, and the aspect of the country is that of a billowy ocean converted into sand. In districts where rain falls and where the inhabitants have dug wells, some of which are 300 feet deep, there are cultivation and settlements; but the soil is throughout sandy, and over the whole region not a stone can be found that is not imported. That part where there is a hard level plain with abrupt sandhills, is called the "Put." Sir Bartle believed that the native terms of "Runn," "Thurr," and "Put," might be adopted in physical geography as denoting varieties of plain which are totally unlike savannah, prairie, steppe, pampa, or any other known description of land-surface. Travellers in attempting to cross the Thurr are subject to sudden death, not, as might be supposed, from the effects of sunstroke, but from some peculiar condition of the atmosphere connected with the intense heat and the nature of the soil, most of the fatal attacks occurring after sunset. The Runn of Cutch and the region north of it are much subject to volcanic disturbance. The great earthquake of 1819 is still remembered by the inhabitants; it was described by Lieutenant Burns, in an admirable paper on the Indus, read before the Royal Geographical Society in 1833. Sir Bartle was inclined to attribute the singular levelness of the salt-plain of Cutch to the great frequency of slight shocks or tremors. During earthquakes, mounds are thrown up some ten or twelve miles in length, and of considerable height, formed, Sir Bartle believed, by a crack or fissure of the surface at right angles to the direction of the earthquake wave, one lip of the fissure being tilted up and overlapping the

other, so as to form a ridge. Small craters and hillocks of ejected sand are sometimes formed on the surface of the Runn, and afterwards subside again to the level of the plain. Dry beds of rivers are traceable throughout the desert tract to the north. From the difficulties of access to the Thurr, it had been for centuries the place of refuge to remnants of various races and nations who had invaded Hindoostan, or succumbed to the fortunes of war. Here are still found specimens of the wild Bheels who claim to be the autochthones and whose blood is essential to ratify every solemn ceremony of the Rajpoot dynasties; Coolies, who are anterior to the earliest Hindoo immigrants; Jutts, who are said to be of Scythian origin and are hardly ever known to forsake their ancestral occupation as breeders of cattle. Hindoos of every tribe and caste are here found, and many representatives are seen of later immigrations—Beloochies, Afghans, Kurds, Arabs, and even Turcomans. One tribe of Rajpoots in the Desert, the Sodas, retain their primitive custom of bringing up all their female children, and, in consequence, all the chiefs in Rajpootana, where female infanticide had become established, have had for ages to take their wives from the humble Soda settlements. The poor Soda chiefs have therefore powerful connections among their wealthy sons-in-law; but, though they often pay a round of visits among them, they are said never to exchange their lives of freedom and simplicity, in the desert, for the palaces of Rajpootana. In the discussion which followed, Lord Napier of Magdala stated his belief that if the improvements Sir Bartle Frere suggested, when Commissioner of Scinde, had been put in execution at the time, a great alteration for the better would by this time have taken place in the desert tract which he had described. — The following new fellows were elected: — Rev. T. H. Braim, John E. Dawson, E. Hutchins, J. Irvine, M. H. Lackersteen, Joseph Moore, Commander Noel Osborn, J. N. Robertson, Joseph Starling, Henry Stilwell, Charles Stenning, John Wilton.

February 28.—Sir R. I. Murchison, president, in the chair. The following Fellows were elected:—Donald Butler, Commander George M. Balfour, W. A. M. Browne, W. L. Barclay, F. W. Buxton, Lieutenant E. F. Chapman, Colonel D. Carleton, Dr. R. H. Hilliard, R. A. Hankey, W. M. James, Colonel Charles E. Law, the Hon. Henry Lyttelton, John Markham, W. C. Midwinter, Major-General W. C. McLeod, Lieutenant-Colonel George W. Raikes, Right Hon. Sir John Rose, W. A. Whyte.

"A Visit to Yarkand and Kaskgar." By R. B. Shaw. The author commenced by saying that the common idea of Tartary was that of a succession of vast plains, over which hordes of barbarians wandered at will with their cattle and tents. He had found the reality widely different. It was a well-cultivated country, containing flourishing cities of more than 100,000 inhabitants, where many of the arts of civilisation are carried on. Security of life and property exists, commerce is protected, the roads are full of life and movement, and markets are held on a fixed day of the week, even in the smallest villages. In the towns extensive bazaars, covered in against the rays of the sun, contain rows of shops, where goods of every kind and from every country are exhibited. In Yarkand alone there are sixty colleges, with endowments in land, for the education of students of Mussulman law and divinity, while every street contains a primary school attached to a mosque. There are special streets for the various trades. In one street will be found the silks of China, in another the cotton goods and prints of Russia, while a third will contain robes made of both materials, three or four of which make up the ordinary dress of the Turki inhabitants. In some streets all kinds of groceries are sold: others are set apart for the butchers, who offer a choice of horse-flesh, camel, beef, or mutton. The first is rather a luxury, but the two last are most abundant, selling at about one penny a pound. The bakers make most excellent light loaves by a process of steaming the bread. The greengrocers present abundant supplies of vegetables in great variety, besides cream nearly as thick as that of Devonshire, and delicious cream-cheeses. Everywhere sherbet made of fruit is sold, which you can get cooled at any street corner, where there are stalls for the sale of ice. There are tea-shops where the great urns are ever steaming, and eating-houses in abundance. Such is the manifold life of this little-known nation; living a life of its own, making history very fast, and looking upon European politics with the same indifference with which its own have been regarded by us. The author, who made his journey with the view of opening the way for trade, especially in tea, between India and Eastern Turkistan, described the manner of his reception by the Governor of Yarkand, and by the Ataligh Ghazee, the ruler of the country, then resident in Kashgar, who now seems firmly established as king over a productive region containing a population variously estimated at from 20 to 60 millions. The Andijanis occupy the chief places in the administration, and form the strength of the army; but their attitude towards the native Yarkandis is very conciliatory, and they are looked upon, not as conquerors, but as brothers in faith and blood, who have delivered them from the yoke of unbelievers and idolaters. The Yarkandis are naturally addicted to commerce and the arts of peace, while the Usbeks of Andijan find their most congenial occupation in administration and arms. Both peoples speak the same language, which is essentially that of the Turks of Constantinople. The Ataligh, Yakoob Beg, impressed Mr. Shaw as a man of remarkable intelligence and energy. Merchants from India are beginning to frequent Yarkand, and it only required the removal of a few obstacles in the hill countries subject to our own influence to open out a field for trade, of which it would be difficult to over-estimate the importance. The whole region forms a vast elevated basin, in Central Asia, about 4,000 feet above the sea-level, surrounded on three sides by a wall of snow-covered mountains, reaching in many places an altitude of more than 20,000 feet. On the east it passes into the sandy desert of Gobi, which separates it from China. All the rivers which descend from the snows of the mountain, flowing eastward, are lost in the sands, and, as there is little or no rain, the soil has to be fertilised by canals and irrigation. The beautiful cultivation and luxuriance of the thickly-peopled parts are entirely due to these irrigating canals, which are exceedingly numerous and carefully kept. Mr. Shaw stated that the King himself superintended the works at a new canal whilst he was there, and even laboured at it himself. The country is separated from the plains of India by the mountain-system of the Himalaya, forming an elevated belt 500 miles broad, with eleven more or less elevated parallel ridges of mountains lying along it. The most northerly of these ridges was styled Kuen-lun by the Chinese, but was not a distinct chain from the rest of the mountains. Mr. Shaw concluded by describing his return journey over the Karakorum Pass. Sir Henry Rawlinson said that the Government of India had considered Mr. Shaw's discoveries of so much importance that they had entered into negotiations with the Maharajah of Cashmere for the purpose of encouraging trade with Eastern Turkistan, and arrangements had been entered into by which all transit duties through Ladak would be abolished. The difficulties of the route northward from Ladak over the Karakorum would probably be obviated by the adoption of the much easier road to the east *vid* Changchenmo, or, still better, by the elevated level plains of Rudok still farther east. The difficult Sanju Pass over the Kuen-lun would also be avoided in future by the adoption of the Yenghi Pass, all that was necessary being the establishment of a fort at its foot to protect caravans from the depredations of hordes of robbers who frequent that district.—The President reminded the meeting that Mr. Shaw was the first European since the days of Marco Polo who had penetrated to Yarkand, and been allowed to return from that wonderful country. The Society's envoy, Mr. Hayward, had reached the place a few days after him; but the two were not allowed to see each other until they were on the way back again.—A second paper was read, "On a Journey through Shantung and a visit to the Tomb of Confucius," by Mr. J. Markham, Consul at Chefoo. The paper contained a most interesting account of the author's reception at Kio-foo, the city of Confucius, and his examination of the monuments and temples connected with the fame of the Chinese sage. The great majority of the inhabitants of the city are descendants of Confucius and bear his surname, and the magistrate's office is hereditary in the family. The result of the author's experience acquired in journeys throughout the length and breadth of this important province was that the middle and lower classes of China were, as a rule, inclined to be friendly to strangers, and that all acts of offence are instigated by the governing class of mandarins.

Royal Institution of Great Britain, March 7. — Colonel P. J. Yorke in the chair. His Royal Highness the Prince Christian of Schleswig-Holstein was elected an honorary member, and W. H. Barlow, A. J. Booth, F. W. Buxton, J. T. Clover, Rev. J. Congreve, G. H. Darwin, F. Galton, Lord R. Gower, R. Grubb, J. Gurney, H. Hoare, J. Houldsworth, Lieut.-Colonel G. Ives, T. Jacomb, E. C. Johnson, Sir J. J. T. Lawrence, F. M'Clean, J. O'Halloran, H. Pechell, F. Pennington, G. Phillips, M. R. Pryor, Dr. J. Rae, Rev. D. M. Salter, A. G.

Sandeman, G. Stone, A. A. de Lille Strickland, C. B. Thurston, the Hon. J. G. P. Vereker, Mrs. Michael Wills, and H. Woods, were elected members of the Royal Institution.

CAMBRIDGE

Philosophical Society, March 7.—The following communications were made to the society:—"On the Centro-surface of an Ellipsoid," by Prof. Cayley. "On the correct expressions for the resistance which bodies experience whilst moving in gases and liquids: with a description of the verifying experiments," by Mr. Potter.

DUBLIN

Royal Irish Academy, February 14.—Rev. J. H. Jellett, president, in the chair. The president read a paper entitled "Researches in the application of Optics to Chemistry," No. I, "Combinations of Nitric Acid with Quinia."—A letter from M. De Vismes Kane, was read, describing the circumstances under which the large stone implement and the curious wooden vessel, which he had presented to the Academy's museum, through Dr. Stokes, were found.—The secretary read a description by Mr. R. R. Brath, of an Ogham inscribed stone at Kiltena, county Waterford.

PARIS

Academy of Sciences, February 28.—M. A. Trécul presented the third part of his memoir on the position of the tracheæ in the ferns. His object in this important paper is to show that there is "no unity of constitution, circulation, and symmetry" in the vascular Acrogens, and in illustration of this view he describes the arrangements of the tracheæ in the following forms:—*Athyrium filix-femina*, several species of *Aspidium* and *Asplenium*, *Struthiopteris germanica*, *Adiantum tenerum*, *Scolopendrium officinale*, *Ceterach officinarum*, and *Gymnogramme chrysophylla* and *calomelanos*.—A letter by Father Secchi on the modifications produced by magnetism in the light emitted by rarefied gases, was read. In this the author described some experiments made by him with a powerful electro-magnet upon Geissler's tubes. He stated that when a tube is placed between or close to the poles of the electro-magnet the light is condensed towards the part of the tube most distant from the magnet, so that instead of a diffused light a bright streak is visible. The effect was said to be very curious, appearing as if the gas itself was displaced, and resembling the great movements of the streamers in the Aurora Borealis. The more brilliant light gives a more brilliant and distinct spectrum, and the author stated that when the gas has a double spectrum, the two spectra are produced separately—one from the brilliant part of the tube, the other from the parts nearer the magnet. The author remarked that the effect of magnetism was as if it narrowed the tubes. He ascribed it to a repulsion of the rarefied gases, due to diamagnetism. M. Dumas remarked that M. de la Rive had been carrying on some experiments of a like nature, the results of which are not yet published, but he believed that in some points they coincided with Father Secchi's.—In a memoir on the spectra of various kinds of simple bodies, M. Dubrunfaut ascribed the double spectra obtained from some vacuum tubes to impurity in the gases employed, and indicated some other sources of error. He referred especially to hydrogen. He also noticed that variations of temperatures may cause anomalies in spectrum analysis, and remarked that the line K *a* of potassium may be made to appear and disappear by raising and lowering the temperature.—Notes of a further investigation of propylic, butylic, and amylic aldehydes were presented by MM. I. Pierre and E. Puchot. Their researches related chiefly to the temperatures of ebullition and densities of these bodies, as to which their results differ considerably from those of former writers.—In a memoir by M. Gustave Lambert on the experimental determination of the form of the earth, that gentleman proposed a simplification of the method of observation by means of the pendulum, and a ready means of measuring a base-line. He submitted his methods to the judgment of the Academy, intending to employ them, if approved, in the projected French Arctic expedition. — M. Delaunay communicated a report by MM. Wolf, André, and Capitaneano, on a bolide observed by them at the Paris Observatory on the 26th February.—This meteor started from between α and β *Canis minoris*, and passed as a yellow streak between Sirius and β *Canis majoris*, when it took the form of a very brilliant, bluish white ball about 5′ in diameter, followed by a broad yellow tail; near ν *Canis majoris*, it burst into several fragments and disappeared. The phenomena commenced at $9^h\ 35^m\ 20^s$ and lasted about 3 seconds. No sound was heard.—M. F. Lucas presented a note relating to the physical state of bodies; M. H. Montucci a memoir on Gauss's method for the reduction of trinominal equations; and M. H. Sainte-ClaireDeville a note by M. A. Martin on Léon Foncault's "method of autocollimation" and its application to the investigation of parabolic mirrors.—M. H. Caron communicated a note on the solution of reductive gases by iron and carburets of iron in fusion, in which he suggested a cause of the spirting of cast-steel and iron in cooling.—M. H. Sainte-Claire Deville made some remarks on this paper.—A memoir on the oxidation of iron by Mr. P. Crace Calvert, was read; from his experiments he concludes that it is the presence of carbonic acid in the air that causes the rusting of iron.—M. Chevreul made some remarks npon this paper.—A note on the dissociation of ammoniacal compounds, by M. F. Isambert, was presented by M. H. Sainte-Claire Deville.—The author noticed the compounds formed by the sulphates of zinc and cadmium with gaseous ammonia, and the tensions of the ammoniacal gas set free from these compounds by the action of heat, which are constant at given temperatures.—M. Campana communicated a note "On the texture and differential character of the Lungs in Birds," in which he described the mode of origin and distribution of the secondary bronchial tubes, which, he stated, terminate in a single tertiary tube, and this in its turn unites with the extremity of another secondary tube. This applies also, according to the author, to the lateral tertiary tubes.—M. Elie de Beaumont communicated an extract from a letter of M. Prost giving an account of earthquake shocks experienced at Nice, and containing a journal of shocks observed during the years 1866—1869.—M. H. Sainte-Claire Deville presented a note by Father Denza on an Aurora borealis and some other meteorological phenomena observed in Piedmont on the 3d of January, 1870.

BERLIN

German Chemical Society, February 29.—C. Liebermann communicated the result of his researches on chrysene, of which large quantities have lately been obtained from coal tar. He has specially devoted attention to the chinone of chrysene, obtained by oxydising this hydro-carbon. The colouring properties of this substance are very inferior to those of its analogous anthracene.—C. Scheibler reported on betain, a base he obtained from beetroot-juice, or molasses. The young roots contain considerable quantities of this substance, and certain molasses furnish as much as 3 per cent. of it. The base has been found identical with oxyneurin, lately discovered in the brain, in eggs, &c., by Leibriech. It is not poisonous, and yields well crystallised salts.—H. Wichelhaus has determined the vapordensity of chloronidtride of phosphorus, thus proving the correctness of the formula $P_3N_3Cl_6$ which had already been fully established by Gladstone and Holmes.—C. Rammelsberg delivered a lecture on meteorites, giving a succinct and interesting history of these remarkable bodies, the existence of which had been regarded as a superstition up to the end of the last century.—Mr. Gordon has prepared Reisets' and Magnus' salts containing ethylamine, aniline, and toluidine in the place of ammonia.—T. Thomsen of Copenhagen sent a paper on the heat of combination. The heat produced by adding an acid to a base attains the maximum when the latter is neutralised by the former. Based upon this observation, the author concludes that sulfhydric acid must be monbasic, a startling fact, which in order to be fully confirmed appears to need further examination.—Two papers were sent in after the last meeting of the society, and printed in the abstracts of that meeting. One is by Kekulé, on the substance described as chloraceten. The author proves the non-existence of this substance, a solution of oxychloride of carbon in para-aldehyde having been taken for a chemical individual. The other paper is by Ceck, describing the combustion of part of the Bohemian diamond, and removing any uncertainty concerning its nature.

German Geological Society.—At the February meeting Dr. Lossen reported on the composition of Karpholithe from the metamorphic slate of Biscaroda, in the Harz Mountains. Hauchecorne and Meyne reported on borings made at Stade for rocksalt. Its discovery was anticipated with certainty. Lindig reported on the borings made at Spurenberg (thirty miles from Berlin), where an immense saltlayer was discovered two years ago. The boring is now 2,630 feet deep, 2,347 of which go through one layer of pure rocksalt! The temperature was found to be 31° 5′ C. at the bottom.

VIENNA

Imperial Academy of Sciences, January 20.—The Ministry of Commerce called upon the Academy to appoint a member to arrange the reproduction of the French standard meter, and also forwarded a nautical instrument for the correction of the course of vessels, invented by Carl Zamara.—A note by Prof. G. Hinrichs of Iowa, on the structure of quartz, was communicated by Prof. von Haidinger.—Prof. E. Mach communicated the results of an investigation by M. C. Neumann upon the vibrations of a string under the bow. His results for the most part confirm Helmholtz's theoretical views.—Dr. Boué presented a geographico-geognostic map of the valley of Sutchesa, and remarked upon its peculiarities.—Dr. A. Friedlowsky communicated a memoir on three cases of augmentation of the carpal and tarsal bones in man.—Prof. F. Simony gave a comparative account of the conditions of temperature in the Lakes of Hallstatt, Gmund, and Langbath, at different depths, and Dr. J. Hann presented a memoir on the decrease of temperature with elevation on the surface of the earth.—The table of the meteorological and magnetic observations at the Central Observatory during the month of December last was also communicated.

February 3.—Memoirs were read by Prof. Rochleder "On some colouring matters from Madder," and by M. A. von Miller-Hauenfels on "The dualistic functions," and "On the electrical current which appears to stand in relation to endosmose." Dr. L. J. Fitzinger communicated the second and concluding portion of his "Critical revision of the family of the *Rhinophylli*," in which he treats of the genera *Ariteus*, *Rhinolophus*, *Rhinonycteris* and *Aquias*.—"Investigation of the white mustard seed." By Professor H. Will. In place of the myronate of potash found in black mustard seed there is in white mustard seed an analogous body sinalbin which splits up into sugar or sulphocyanogen compound and acid sulphate. The sulphocyanogen compound is not volatile, it contains an oxygenated radicle akrinyl C_7H_7O. The acid sulphate contains in place of potassium sinapisin. The sulphocyanide of akrinyl freed from sulphur and treated with alkali when in the state of nitryl yields ammonia and a salt of the acid $C_8H_8O_3$, which melts at 136° C, and is not identical with any known acid of the same formula.

Geological Institution, February 15.—Herr von Hauer in the chair. Prof. von Ettingshausen communicated the results of his study of the fossil flora from the environs of Berlin, Bohemia. Nearly five hundred species have been determined from six beds of different age. The oldest of them—the freshwater-chalk of Kostenblatt and the strata of Kutschlin—correspond with the Aquitanian series; the plastic clay of Priesen, as well as the clay and spherosiderit of Languageyd, belong to the middle part of the Miocene formation. The menilites and opales of the Sichrow valley, as well as the shists of Sobrusan, contain the plants of the Oemingen series. Herr Flanenschild pointed out that the existence of large layers of the so-called Alpine chalk (Alpenkreide), the mud of glaciers, which eroded the dolomitic rocks, indicates the existence of old glaciers in the Alm- and Steierling valleys, Upper Austria. This mud consists, therefore, of carbonate of lime and carbonate of magnesia, and, when burnt at a low temperature, gives a good hydraulic cement.—Herr. Ch. Paul exhibited detailed sections of the small mountain range near Homonna, North-eastern Hungary, consisting of different layers of the triassic, rhætic, liassic, jurassic, and cretaceous formations. Of high interest is the discovery of marls with fossils of the *Gault* series, which are so very rare in the eastern Alps and Carpathians.—Herr Stache exhibited geological maps of the environs of Unghvar and Mandak, North-eastern Hungary, which he had surveyed last summer. Trachytes with their tufts, and Carpathian sandstones of Eocenic age, are the prevailing formations.

DIARY

THURSDAY, March 10.

Royal Society, at 8.30.—On some Elementary Principles in Animal Mechanics (No. III.): Rev. S. Haughton.—On the Contact of Conics with Surfaces: W. Spottiswoode.—On the Spotted Area of the Sun's Visible Disc from the Commencement of 1832 up to May 1868: W. De la Rue, B. Stewart and B. Loewy.—Tables of the Numerical Values of the Sine-Integral, Cosine-Integral, and Exponential-Integral: J. W. L. Glaisher.

Society of Antiquaries, at 8.30.—Roman Inscription in the Disney Collection: Mr. H. C. Coote.

Zoological Society, at 8.30.—Dinornis (Part XV.): Professor Owen.—New species of *Ampullaria*: Dr. J. C. Cox.—Birds of Veragua: Mr. O. Salvin.—New birds from the Yantze-kiang: Mr. R. Swinhoe.

Mathematical Society, at 8.

Royal Institution, at 3.—Chemistry: Prof. Odling.

London Institution, at 7.30.—Swiney Lecture: Dr. Colbold.

FRIDAY, March 11.

Royal Institution, at 8.—On Art: Mr. Westmacott.

Quekett Microscopical Club, at 8.

Astronomical Society, at 8.

SATURDAY, March 12.

Royal Institution, at 3.—Science of Religion: Prof. Max Müller.

Royal Botanic Society, at 3.30.

MONDAY, March 14.

Medical Society, at 8.—Anniversary.

Society of Arts, at 8.—Cantor Lecture: Dr. Paul.

TUESDAY, March 15.

Royal Institution, at 3.—Nervous System: Dr. Rolleston.

Anthropological Society, at 8.—On Strange Peculiarities observed by a Religious Sect of Moscovites, called Scoptsis: Dr. Kopernicky and Dr. Barnard Davis.—Phallic Worship: Mr. Hodder Westropp.—Consanguineous Marriages; Mr. George C. Thompson.

Statistical Society, at 8.—The Financial System of the Free Church of Scotland: Rev. D. Buchanan.

Pathological Society, at 8.

Institution of Civil Engineers, at 8.—1. Discussion upon Mr. Fox's paper "On the San Paulo Railway;" 2. and if time permits, the following paper will be read, "On the Conditions and the Limits which govern the Proportions of Rotary Fans:" Mr. Robert Briggs.

WEDNESDAY, March 16.

Society of Arts, at 8.—Surface Decoration: Mr. Pitman.

Royal Horticultural Society, at 1.30

Meteorological Society, at 7.

THURSDAY, March 17.

Royal Institution, at 3.—Chemistry: Prof. Odling.

Royal Society, at 8.30.

Linnean Society, at 8.—The Flora and Fauna of Round Island: Sir Henry Barkly.—Algæ found in the North Atlantic Ocean: Dr. Dickie.

Chemical Society, at 8. Zoological Society, at 4.

Numismatic Society, at 7. Antiquaries' Society, at 8.30.

BOOKS RECEIVED

English.—The Bottom of the Sea: B. Z. Sonrel; illustrated. Translated and edited by Elihu Rich (Sampson Low and Marston).—Weapons of War: A history of arms and armour from the earliest periods to the present time: A. Demmin; illustrated. Translated by C. C. Black (Bell and Daldy).—Sketches of Life and Sport in South Eastern Africa: C. Hamilton; illustrated (Chapman and Hall).—The North British Review (Williams and Norgate).—A Search for Winter Sunbeams in the Riviera, Corsica, Algiers, and Spain: S. S. Cox (Sampson Low and Marston).—The Natural History of Man: Rev. J. G. Woods; illustrated (Routledge and Sons).—Our Iron-clad Ships: E. J. Reed (Murray).—Physical Geography: D. T. Ansted.—The Earth's History; or, First Lessons in Geology: D. T. Ansted.—The World we live in; or, First Lessons in Physical Geography: D. T. Ansted (W. H. Allen and Co.)—The Science and Art of Arithmetic: Sonnenschein and Nesbitt (Whittaker and Co).—Treatise of Medical Electricity: J. Althaus.

Foreign.—Nachrichten der K. Gesellsch. der Wissenchaften, 1869. Petermann's Mittheilungen—Manuel des Humeurs: F. Papillon.—Die Parasiten der weiblichen Geschlechtsorgane des Menschen und Einiger Thiere nebst Beiträge: Dr. D. Haussmann.—Archiv für die Landes durchforschung-Böhmen.—Neue Untersuchungen über den elektrisirten Sauerstoff: Dr. G. Meissner.—Lehrbuch zur Bahnbestimmung der Kometen und Planeten; T. Oppolzer.—Beitrage zur Petrographie der plutonischen Gesteine: J. Roth.—Handbuch der Physiologisch-und Pathologisch-chemischen Analyse: F. Hoppe-Seyler.—Chemismus der Pflanzenzelle: Dr. H. Karsten. (Through Williams and Norgate.)

CONTENTS

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